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Materializing a Traffic-Survey Plan

System of arterial routes worked out by traffic survey of Cleveland, Ohio, metropolitan area is being materialized as concrete locations and designs by special planning division of Cuyahoga County surveyor's department

By R. C. Chaney
*Planning Engineer,
Cuyahoga County Surveyor's Office,
Cleveland, Ohio*

ACTIVE PLANNING on a broad program of highway development in the metropolitan area of Cleveland, Ohio, was first undertaken with a specific objective, following the survey of highway facilities and requirements of the area and the reported plan of 1928 (*ENR*, Jan. 24, 1929, p. 152). This survey, at the instance of the board of county commissioners of Cuyahoga County, was made under a cooperative agreement with the U. S. Bureau of Public Roads and was jointly financed by the two agencies. The work was notable for its comprehensive application to the region, for the competence of its execution and for having obtained the approval and cooperation of the various county and local governmental agencies concerned, as well as their commitments in advance to accept it and to undertake the improvements as determined by the survey. This survey is considered to have solved adequately the problem of the immediate needs of the region, to the extent of diagnosis and prescription.

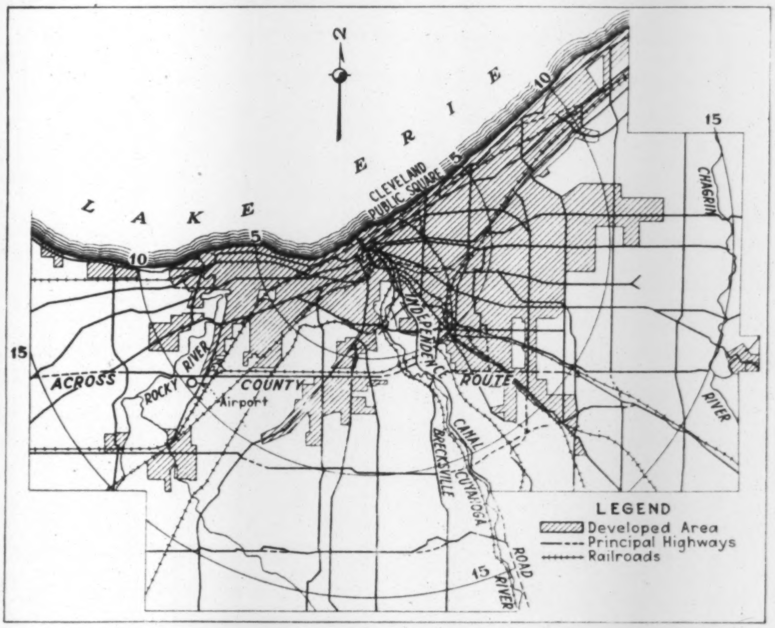


Fig. 1—Map of Cuyahoga County and Cleveland, Ohio, showing developed area and principal roads included in traffic relief plan of 1928.

The placing of the plan on the ground and the design of the highways as concrete facilities were necessary preliminaries to the construction of the improvements. Some of the elements of the plan presented little difficulty, being improvements that might be made within existing rights-of-way with little change. In many cases, however, correction of alignment, alteration of location or new openings were found necessary, involving special attention and in some instances extensive study.

Study was required distinct in character from the standardized preparation of contract plans, and special provision was made in January, 1930, for

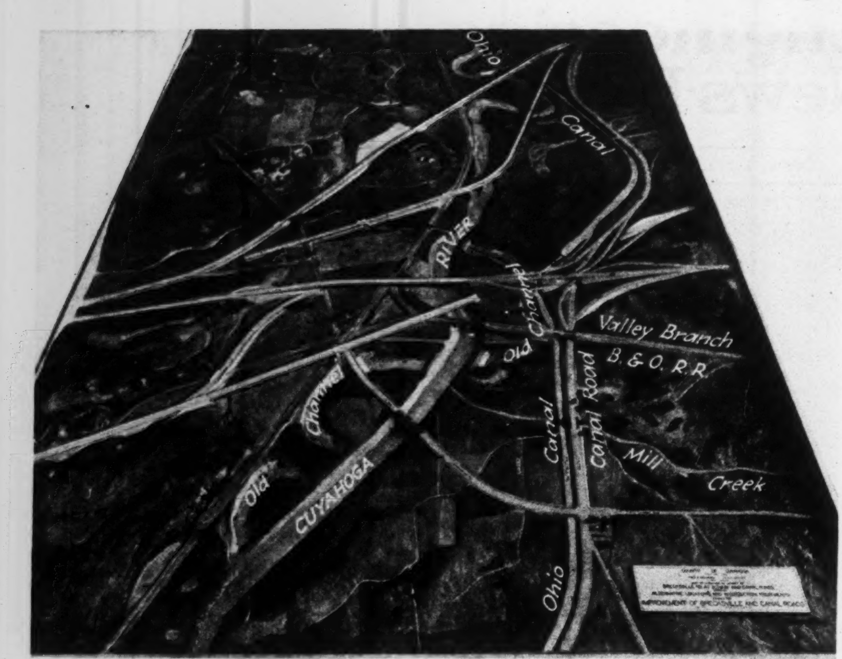


Fig. 2—Relief map prepared for making alternative studies of complicated intersection and crossing situation in extending Brecksville Road.

this work. The county surveyor, Fred R. Williams, created a planning division in his department, the primary purpose of which was to give engineering expression to the prescribed relief improvements and to such others as might require attention. As the acquisition of right-of-way was intimately associated with the planning and surveys for location, the division of land and claims was made a part of the new division, which was charged with the preparation of preliminary and final studies and location plans, maps, plates, project estimates and reports through the development of the project and the acquisition of right-of-way, but exclusive of the contract construction plans.

The organization of the division, after some months of experiment and of fitting of personnel to work, took form and its operation became standardized. Except for the writer, who was in charge, the staff was made up by the assignment of men selected from the employees of the surveyor's office, rather than by additional appointments. The associated land and claims division handles negotiations for right-of-way with incidental claims adjustment, for reference to the surveyor and submission to the Board of County Commissioners. The chief, his assistant, a record clerk and a stenographer handle this work.

The engineering phase of the planning division's work is divided between two sections, both under the detailed direction of the assistant engineer. Surveys, computations and drafting for the preparation of right-of-way plates and maps are the function of the right-of-way section the office work of which is in charge of a plotting engineer assisted by three draftsmen. The project or planning section, also under a plotting engineer with four draftsmen, prepares route studies, location plans and project estimates, with such special work as traffic surveys, local treatment drawings and models. The surveys required are made by field parties assigned to the division from the surveyor's organization and are directed by the assistant engineer.

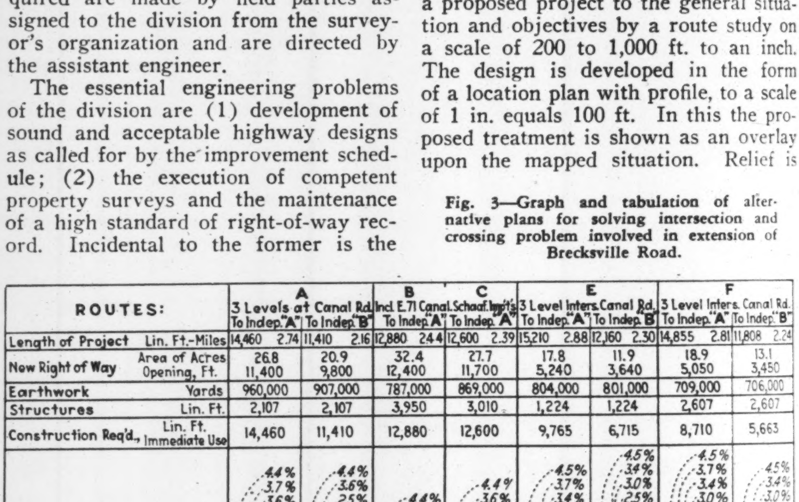
The essential engineering problems of the division are (1) development of sound and acceptable highway designs as called for by the improvement schedule; (2) the execution of competent property surveys and the maintenance of a high standard of right-of-way record. Incidental to the former is the obtaining of situation or topographical information.

The preliminary planning of an improvement often develops differences of opinion as to location and treatment. Such disputes may delay accomplishment or may lead to solutions that later prove to be unsatisfactory. A specific purpose in the formation of the planning division was the preparation of situation information and design that might eliminate unsuitable proposals and make available to the determining authority the basis for sound action.

Surveys for situation information, ownership and location, both for viewing and right-of-way acquisition, are supervised by the planning division. From the survey parties of the county surveyors' office assignments are made to the division as required. Parties specially experienced in property, topographic and location surveys are used in their respective functions as necessary. Situation surveys previously made by cross-section or by transit and stadia are now made, except in very simple cases, by plane table from control surveys. The division has in the field from four to eight parties, the highest number used in the two years being eleven.

The study of highway projects by the division is expressed in standard maps and plats, estimates, reports and special sketches and models or relief maps. It is usual to illustrate the relation of a proposed project to the general situation and objectives by a route study on a scale of 200 to 1,000 ft. to an inch. The design is developed in the form of a location plan with profile, to a scale of 1 in. equals 100 ft. In this the proposed treatment is shown as an overlay upon the mapped situation. Relief is

Fig. 3—Graph and tabulation of alternative plans for solving intersection and crossing problem involved in extension of Brecksville Road.



ROUTES:	A 3 Levels at Canal Rd. To Indep."A"	 To Indep."B"	B Incl. E.71 Canal. To Indep."A"	C Schaaf. Imp't's To Indep. "A"	E 3 Level Inters. Canal Rd. To Indep."A"	 To Indep. "B"	F 3 Level Inters. Canal Rd. To Indep."A"	 To Indep."B"
Length of Project Lin. Ft.-Miles	14,460 2.74	11,410 2.16	12,880 2.44	12,600 2.39	15,210 2.88	12,160 2.30	14,855 2.81	11,808 2.24
New Right of Way Area of Acres Opening, Ft.	26.8 11,400	20.9 9,800	32.4 12,400	27.7 11,700	17.8 5,240	11.9 3,640	18.9 5,050	13.1 3,450
Earthwork Yards	960,000	907,000	787,000	869,000	804,000	801,000	709,000	706,000
Structures Lin. Ft.	2,107	2,107	3,950	3,010	1,224	1,224	2,607	2,607
Construction Req'd., Lin. Ft. Immediate Use	14,460	11,410	12,880	12,600	9,765	6,715	8,710	5,663
Gradient in Excess of 2%	4.4% 3.7% 3.6% 3.0%	4.4% 3.6% 2.5% 2.2%	4.4% 3.6%	4.4% 3.6% 2.83%	4.5% 3.7% 3.4% 3.0%	4.5% 3.4% 3.0% 2.5% 2.2%	4.5% 3.7% 3.4% 3.0% 2.15%	4.5% 3.4% 3.0% 2.2%
Lin. Ft.	4,825	3,650	2,700	4,100	5,725	4,550	5,080	3,060
ΣΔ	401°-14′	266°-44′	236°-22′	204°-11′	388°-31′	254°-01′	259°-16′	120°-31′
Curvature: Total Change of Direction Length Lin. Ft. % Project Length	7,085 49.0%	4,735 41.5%	4,885 37.9%	5,375 42.7%	7,345 48.3%	4,995 41.1%	5,295 35.6%	2,825 23.9%
Construction Cost	2,415,000	2,356,000	3,086,000	2,656,000	1,799,000	1,740,000	2,238,000	2,179,000

BRECKSVILLE PLAN	TO INDEPENDENCE "A" I 3 Level	 II 2 Level	 III Grade	TO INDEPENDENCE "B" I 3 Level	 II 2 Level	 III Grade
A	2,415,000	2,724,000	2,404,000	2,356,000	2,473,000	2,216,000
B	———	3,086,000	———	———	———	———
C	———	2,656,000	———	———	———	———
E	1,799,000	2,106,000	1,788,000	1,740,000	1,855,000	1,600,000
F	2,238,000	2,547,000	2,227,000	2,179,000	2,398,000	2,039,000

indicated by contours; ownership, development and features influencing the design are shown. In many cases selection of route or determination of specific location has necessitated the preparation of alternative designs for better comparison or suitability and cost.

In the two years' operation of the planning division some 60 projects have been prepared, with an aggregate length of about 120 miles, including alternatives. This project design is followed in the cases of projects undertaken by the preparation of establishment maps to illustrate the legislative action creating the highway and based upon property surveys. These are followed in turn by dedication plats of the various individual parcels for execution and record as instruments conveying to the county the highway rights to the land. In 1931, 475 such plats were prepared for use in proceedings initiated.

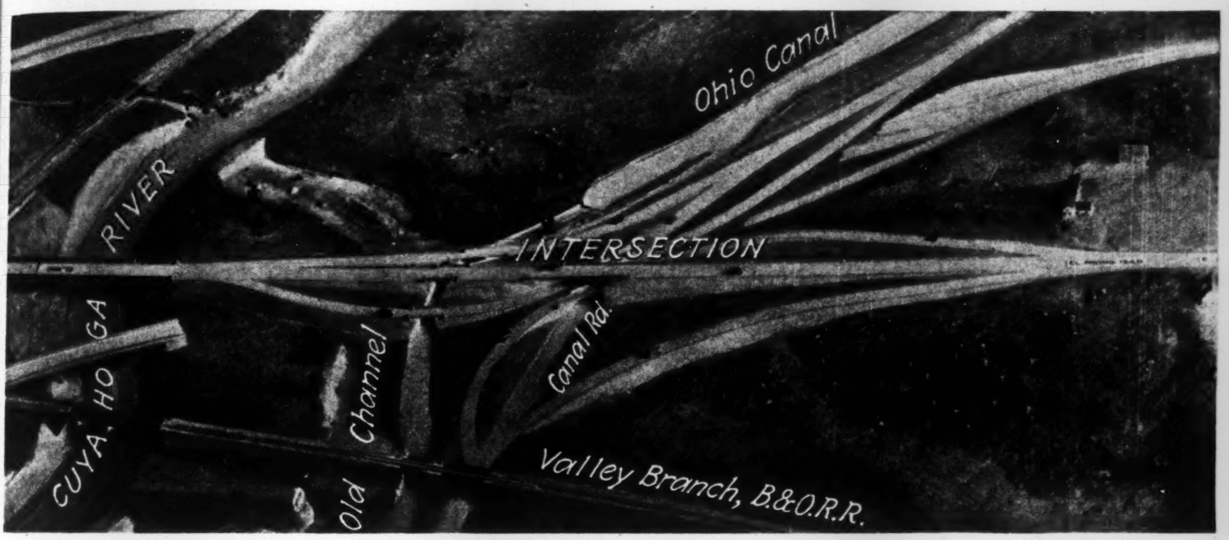


Fig. 4—Enlarged view of proposed three-level highway intersection of Brecksville and Canal Roads shown in Fig. 2.

Two examples from these many projects are sufficient to indicate specific methods. They are shown on the general map, Fig. 1, giving the principal roads contemplated in the general plan of 1928.

A belt highway

The needed relief highways prescribed in the study of 1928 included a trans-county route to pass south of the developed city. This 24-mile project, extending from the west county line to within 7 miles of the east line, is to serve as a collector and distributor of traffic to and from the many radial highways intersected. Passing the Cleveland municipal airport, crossing two parkways of the metropolitan park system, a city park, seventeen principal radial highways and nine railroads, the variety of its traffic service is marked.

Reconnaissance by the planning division of various tentative lines in the 10-mile section, including the crossing of the Cuyahoga, indicated three plans as feasible. These were surveyed, mapped, designed in outline and estimated. Comparison was made upon the basis of length, required new right-of-way, accessible frontage, earthwork, length of structures required, construction required in addition to existing pavement on route, total rise eastbound, gradient in excess of 3.5 per cent, total curvature in degrees of central angle, percentage of length on curve and construction cost. Relative suitability of the alternative routes was indicated as conclusively as may be expressed by such an analysis. There were considerations applying to each of the plans that supplemented the comparative data. Nevertheless the comparison insured practicality and soundness in the selection. The alternative recommended differed somewhat from that contemplated in the report of 1928, the analysis indicating the availability of a more suitable location.

This highway is planned as a 40-ft. roadway in a 100-ft. right-of-way. Gradients do not exceed 4 per cent, except a 1,300-ft. section of 5 per cent. In all instances except two the curvature is held to a radius of 1,000 ft. or greater. These exceptions in grade and alignment occur in the east approach to the Cuyahoga Valley, where it was necessary to accept curvature as sharp as 800 ft. in radius. Vertical curves at summits are of such lengths as to afford visibility for at least 500 ft. Grade separation is planned at intersections with the principal radial highways. Heavy construction includes the Cuyahoga River crossing, involving a structure of 1,900 ft., a 1,600-ft. embankment 80 ft. high across Mill Creek Valley and a 2,100-ft. structure over the Pennsylvania Railway and Broadway.

The recently widened and reconstructed Brecksville Road, northerly about 8 miles from the south county line, stopped 2 miles short of its objective, the southerly terminus of Independence Road leading to the center of Cleveland. This gap includes the crossing of the Cuyahoga River, and during 1931 the county's attempt to acquire the right-of-way encountered exorbitant claims, blocking the undertaking. The planning division thereupon re-opened the study of route location. Two solutions were prepared contemplating the use in part of the existing road rather than its relocation in a parallel ravine. Analytical comparison was made of those locations and of three previously considered, upon the basis of length, gradients, curvature and construction cost.

The problem was complicated in the vicinity of the river crossing by the Baltimore & Ohio Railroad along the south bank, its Valley Branch, the old canal operated as a water-supply channel under lease and six other existing county roads, all of which terminate in the square mile about the crossing. Canal Road, also under study, is to merge in this situation with Brecksville Road, the two forming the Independence Road project into Cleveland.

Relief map prepared

To present this situation graphically, a model or relief map (Fig. 2) was made, to a scale of 1 in. equals 50 ft. The area reproduced was 1¼ square mile. Various alternatives of Brecksville Road and of Independence Road were modeled, as were alterations in other roads, in the railroad grade and in stream locations.

The relief map, 8x12 ft. in size, was molded in plaster upon a base of prestwood, in four sections to permit moving. The base sections were assembled as a table on which the coordinated positions of points of the maps were located. The 100-scale map was enlarged by photostat to the scale of the model. The map was then assembled on the base and the model built upon it. Finishing nails were driven to grade into the base on contours and road centers and to mark various critical features. The sections were framed into the table with a sideboard on all sides, which was carefully trued to plane and used as a datum for a straight-edge with scale used in setting grades over the area. A duplicate set of map sections furnished control after placing the plaster. Detail was developed from ground and aerial photographs. Essential features of development were reproduced, to portray the actual situation with sufficient truth for the purpose. Great refinement was avoided. The model when finished as to form was given expression by color, and labels were attached indicating elevations and road names and identifying the various alternative plans.

A three-level crossing

An interesting phase of this problem was the design of interchange facilities between East 71st St., Brecksville, Canal and Independence Roads. It so happens that the topography of the situation favors a treatment that permits continuous movement on all those roadways without stops or conflicts of currents. This is made possible by a three-level grade separation (Fig. 4). East 71st St., which at present carries Brecksville and Canal Road traffic to the city via Broadway, will retain much of its importance after the construction of Independence Road. It would, in this plan, be extended directly south to merge with the new Brecksville Road. Its grade is such that it passes over the proposed extension of Canal Road at a height that permits the one-way southbound connection of East 71st St. to Canal and the one-way northbound continuity of Brecksville into Independence to pass, side by side, between the two.

In addition to permitting continuous movement, this three-level separation of grades provides favorable grades for all four ways. By adapting the design to the peculiarly favorable topography the grade of each road in its passage through the situation is practically that which would have been chosen had there been no consideration of interchange with the other roads. This rational and favorable design is not obtained at great cost. The two-level separation and the grade intersection, both much less suitable from an operation standpoint, are estimated to cost 141 and 100 per cent, respectively, of the estimated cost of the three-level design. These alternatives impose upon Canal Road a rise and fall of 30 and 50 ft., respectively, whereas in the three-level design that road is on a level grade.

This plan involves relocating the Cuyahoga River for about a quarter of a mile, which, with the material excavated in the area of the separation, provides the embankment for approaches and materially shortens the structure required to carry Brecksville Road over the river valley.

Relative construction costs of the five alternative plans, each with its possible variations of treatment, were indicated in tabulated form (Fig. 3). This comparison of solutions indicated that the study was successful in producing a substitute for the route found not available at a fair right-of-way cost. Plan E appeared preferable to those involving the prohibitive relocation, possessing particular advantage in permitting favorable stage construction and early completion for use, as well as being estimated to cost 25 per cent less than the cheapest of the three earlier plans. Half of its required right-of-way area constitutes the widening of an existing 66-ft. highway, which is subject to a municipal setback regulation preserving the desired width free from buildings. The widening may be deferred for years. In this section there is a 30-ft. new brick pavement, which will serve for a few years without serious need for widening. The routes following the proposed relocation in the ravine required the construction of a drainage conduit, grading and construction of an underpass, all of which would delay the paving of the roadway at least one year. Plan E is now available for service a large portion of its length. It should be stated that the relocation was determined upon prior to the creation of the planning division.

An improved variant of this low-cost solution was developed and estimated. Plan E, offering a direct and simpler river crossing and south approach, eliminated here 130 deg. of curvature and 700 ft. of gradient in excess of 4 per cent. This improved alignment and grade is obtainable at an estimated cost exceeding that of plan E by 25 per cent but 8 per cent less in construction cost than the cheapest of the earlier plans.

Summary

The particular purpose served by the planning division in such study as is indicated has been the advance development of improvement projects in outline design. This is believed to insure not only sound determination of location and treatment but coordination of the improvements and of their scheduling. The creation of the division followed the adoption of a highway improvement policy by the county, which involved 281 miles and the expenditure of $41,200,000 within ten years. Much of this work required engineering preparation preliminary to its crystallization as concrete projects of definite location and treatment. It was determined that this should be handled through a unit separate from but associated with that occupied with the preparation of construction plans. It was recognized that if the planning were to reflect the maximum service, it should be a continuing effort and well ahead of current needs and programs. The existence of a considerable list of projects to be studied has given little opportunity for the initiation of new proposals of importance. There are, still practically untouched, improvements contemplated for the future that will engage the attention of the planning division for some time. Among them is the long-contemplated boulevard along the lake shore.

Manufacture of Sound-Absorbing Materials Seen As New Industry

Manufacture of sound-absorbing materials for use in correcting the acoustic quality of auditoriums is an industry, 75 per cent of whose development has occurred within the past three years, according to the Bureau of Standards at Washington, where extensive tests on these new materials have been carried out. The underlying principles of architectural acoustics have been known for nearly 40 years, but little work was done in this field until the advent of talking pictures made many theatres that had been built for silent pictures acoustically useless. The materials available several years ago were limited in number, and some of them were serious fire risks.

In 1928 the facilities for this work were limited to two laboratories, both in Illinois. In the fall of 1928 the Bureau of Standards completed a reverberation room for making such tests and placed it in service. During the rest of that year its facilities were used by two manufacturers. In 1929 seven different firms sent materials for measurement, and this number was increased to 18 in 1930 and 23 in 1931, when the total number of samples measured was 97. For the first half of 1932 the demand for service of this character has been considerably in excess of the 1931 rate.

In 1930 the bureau issued a circular letter on the subject of acoustic materials. The latest edition of this circular (April, 1932) lists 37 different materials with several varieties of each.

During the past two years a study of the influence of atmospheric conditions on sound absorption has also been made. It has been found that when the air is very dry the sound is absorbed much more readily than when the air is full of moisture. Also when the temperature is high the sound is absorbed better than when it is cold. This increased absorption is most pronounced for sounds of high pitch. The problem is of considerable interest in broadcasting studios, where an attempt is made to keep the absorption constant by the use of air conditioning. It has also been found that the rate of decay of sound in a room is influenced by the area of absorbing material present and its distribution. Research Paper No. 465, in the August number of the Bureau of Standards *Journal of Research*, gives a complete account of this work.

Model Tests of Soil Action Under Footings

Results of tests at civil engineering high school at Moscow are shown by photographs taken through glass containers of soil movement under piles and various forms of footings

By G. I. Pokrowski and N. W. Laletin
Foundation Laboratory, Civil Engineering High School, Moscow, U.S.S.R.

BY RESORT TO containers with sides of glass, the foundation laboratory of the civil engineering high school of Moscow, Russia, is securing photographs, more than a dozen of which are shown here, of soil movement under piles and footings of various forms.

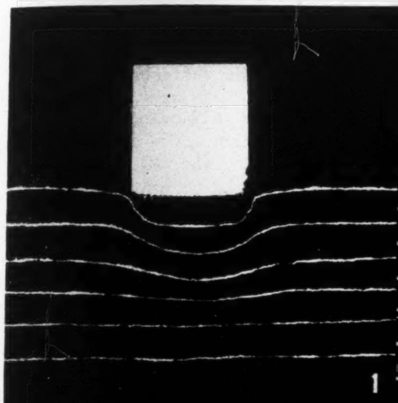
As deformation of soils depends largely on the dimensions of the foundations, it is realized that these model tests can serve only to disclose the general character of the deformation. It is believed, however, that the data they furnish can lead to clearer understanding of foundation action and thus will be useful. This article is a brief summary presentation of the results obtained in the tests as indicated by the photographs. —EDITOR.

IN THE model tests illustrated in this article the soil was an artificial fill of sand and a clay. When moistened this mixture showed little change of volume and did not develop cracks when dried out. To observe the deformation, layers of pulverized chalk were inserted between layers of the soil. The white streaks, being originally rectilinear, show clearly by the curves they take the character and extent of the soil deformation.

The friction of the soil against the glass is insignificant and had no appreciable effect on the deformation. All the deformation cases under discussion were obtained under loads from 0.5 to 3 *kg cm*^{2} (about 7 to 42 lb. per sq.in.). The foundation sizes are reproduced in the models on a scale of 1:10 to 1:20. The order of deformation values is the same as in real practice; this is necessary if the models are to convey a clear idea of the actual state.

Footing tests

In the plain base surface footing (Fig. 1) all the layers are compressed up to a certain depth under the foundation. Under the edges the streaks show a considerable curvature. In general, the nearer the deformed layer is to the foundation base the sharper is the curvature. Extending outward, the thickness of the layers becomes more normal, which indicates swelling, as well as the presence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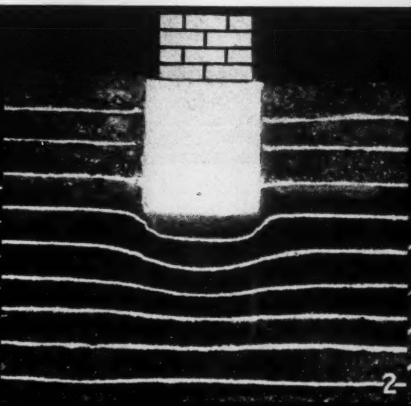
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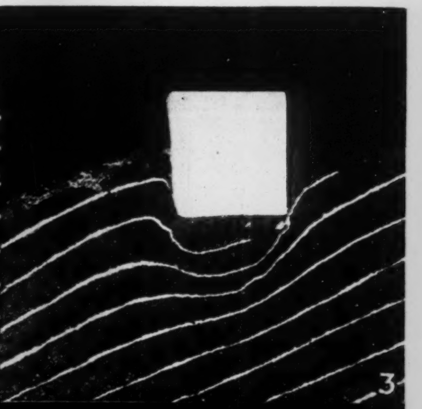
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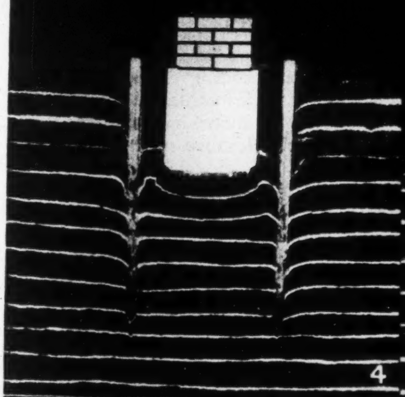
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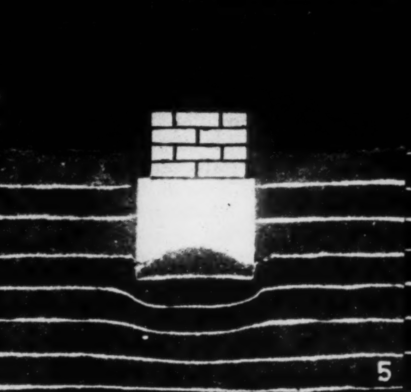
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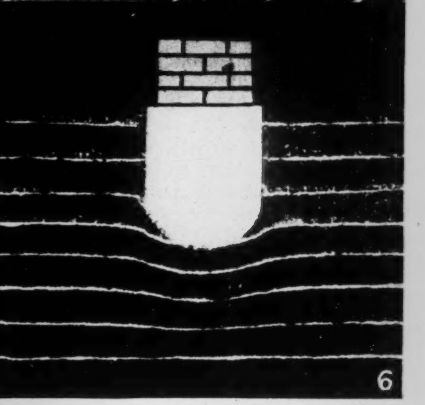
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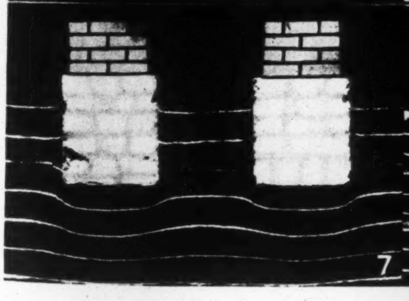
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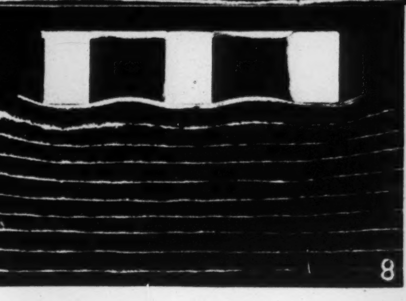
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Fig. 1—Plain-base surface footing.

Fig. 2—Plain-base deep footing.

Fig. 3—Footing on sloping ground.

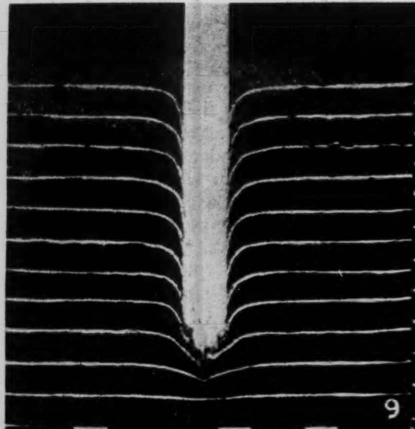
Fig. 4—Footing in cofferdam.

Fig. 5—Concave base footing.

Fig. 6—Convex base footing.

Fig. 7—Two adjacent footings.

Fig. 8—Row of column footings.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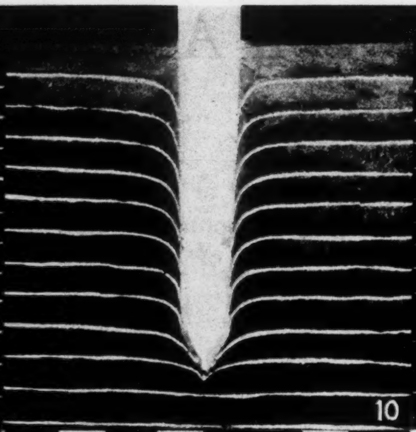
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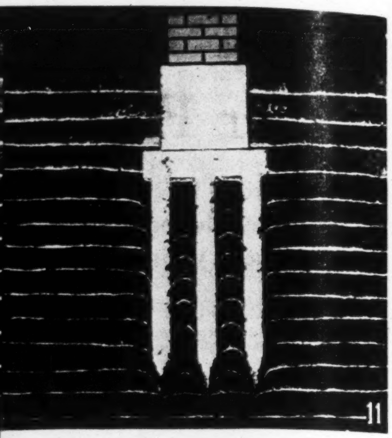
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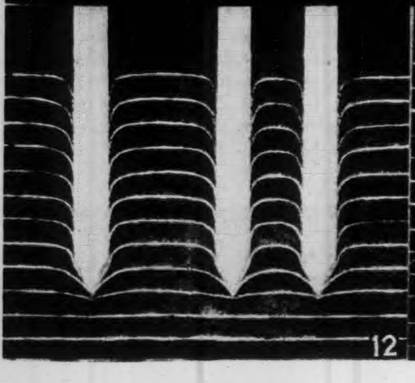
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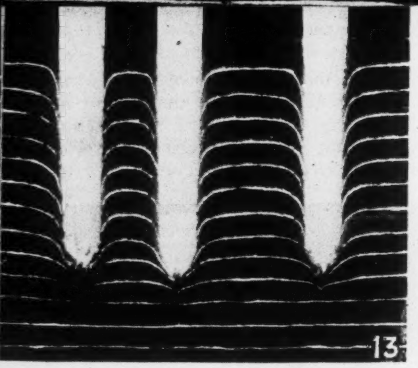
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Fig. 9—Deformation by cylindrical pile.

Fig. 10—Deformation by tapered pile.

Fig. 11—Deformation by pile cluster.

Fig. 12—Cylindrical piles irregularly spaced.

Fig. 13—Tapered piles irregularly spaced.

of forces by which the layers are compressed horizontally.

The varying thickness of the soil layers is due to the fact that the soil itself, as well as the water contained in it, is shifted during the settlement of the foundations. Owing to the shifting of the water, the soil under the foundation loses part of its porosity during the settlement, while around the foundation the porosity is increased, accompanied by change in the thickness of the soil layers. If lines are drawn on the model in accordance with the initial position of the chalky streaks, the areas limited by these lines on the top and by the deformed chalky lines on the bottom will form approximate diagrams of pressures under the foundation at a given depth. This will be right in so far as the deformation of soil is proportional to the force and as the protrusion of the soils at the foundation borders can be neglected. It must be borne in mind that the protrusion mentioned can amount to one-third of the foundation settlement.

In a deeper footing (Fig. 2) the soil is pressed out from under the base during the settlement with more difficulty, the deeper the base. The zone of soil involved in the deformation under otherwise identical conditions decreases as the depth of the foundation increases. In the model under consideration this causes a sharper curvature of the layers under the foundation borders than when the foundation is not deep. A still sharper curvature of the layers shows that the corresponding deformation requires greater forces than those active in a shallow foundation. Thus the given model illustrates the physical cause of the fact that the safe load of the soil may increase with the depth of the foundation.

A footing in sloping ground (Fig. 3) can lead to landslides, particularly if the cohesion and friction in the soil is weakened by considerable moistening.

The settling of foundations is generally accompanied by the pressing out of soil, as well as of water and air from under the foundation base. In some cases it is just this pressing out that can lead to dangerous settlements. This danger can be averted by surrounding the foundation by sheetpiling (Fig. 4). This prevents the deformation of the soil from expanding sidewise under pressure, as is seen on the model. The deformation extends mainly downward into deeper soil layers. However, these layers can only be very slightly compressed under normal conditions. Therefore a foundation that is surrounded by sheetpiling always has a smaller settlement.

As the settlement of foundations is accompanied by an important fact—the pressing out of the soil sidewise from under the foundation base—one of the measures for lessening this protrusion may consist in giving the foundation base a concave shape. The resulting soil deformations are represented in Fig. 5. It should be noted that the soil layers show strong curvatures at acute angles along the edges of the foundation slab.

With a convex base (Fig. 6) the soil deformation is far more uniform and presents no sharp breaks of soil layers.

Two footings closely adjacent may affect each other, as in Fig. 7. In general, the level of the soil surface between foundations will be lower than outside, and the footings may tip because the bearing capacity of the soil will in general be different at the inner and outer border.

When a concentrated load due to a row of columns is to be transmitted to the soil, it is usually necessary that the stresses in the soil be distributed as uniformly as possible. This condition may be attained by means of a rigid foundation slab supporting the columns. The effect of concentrated loads produces in the slab bending moments and corresponding deformations that Fig. 8 illustrates in a somewhat magnified scale. Owing to flexture of the slab, both stresses and deformations are not uniform in the upper layers of the soil. As the depth increases, the rate at which this uniformity diminishes becomes proportional to the increase of the internal friction and cohesion of the given soil.

Pile tests

Fig. 9 illustrates the deformation of the soil around a vertically driven cylindrical pile. The driving of a cylindrical pile compacts the soil, and the soil is carried along by the force of friction in the direction of the pile movement. Therefore piles present an excellent means of consolidation and internal tamping of soils, providing a safe foundation bed.

In contrast with a cylindrical pile, the driving of a tapered pile (Fig. 10) produces simultaneously a slanting and a compression of the soil along the whole surface of the pile. This results in a

more considerable and more uniform consolidation of the soil along the height of the pile and explains the increased carrying capacity of tapered piles.

In the absence of piles the soil deformations, even in the case of a considerable settlement of a foundation, are transmitted for a comparatively small depth. But if it is necessary to decrease the settlement of a foundation, piles may be very useful. It is interesting to note (Fig. 11) an enormous difference in friction at the foundation walls and along the piles. Note also the voids formed during the settlement near the projections of the grillage slab, in cohesive (clayey) soils.

Piles in a group influence one another. Fig. 12 illustrates soil deformations between cylindrical piles spaced at various intervals. The model shows that besides a curvature of individual layers the soil, between piles driven at a small distance from one another, may have a downward displacement. The same downward effect occurs in more marked form with tapered piles, as is illustrated in Fig. 13.

A pile subjected to horizontal pull after driving appears to rotate about a certain zero point. In cohesive soil voids may develop. In large lateral movement the pile is somewhat pulled out of the soil.

Notes on Abutment Sluicing at St. Gabriel Dam No. 2

By E. C. Eaton,
Chief Engineer, Los Angeles County Flood Control District, Los Angeles, Calif.

ABUTMENT overburden, totaling 28,000 cu.yd. of earth and rock, was removed by hydraulic operations from the site of the San Gabriel No. 2 dam in accordance with the specifications of the Los Angeles County Flood Control District, which did not permit the use of explosives. The rockfill structure which will be 265 ft. high above streambed with a base thickness of 765 ft., will form part of the flood-control and water-conservation development of the flood-control district on the San Gabriel River. Preparation of the site required removal of overburden within a pay area of 3.37 acres on the right abutment and 2.88 acres on the left. Data obtained from these sluicing operations cover a subject on which information is not abundant.

About 450 ft. upstream from the heel of the dam a three-stage centrifugal pump was set up in the streambed and directly connected at each end to a 250-hp. motor. The rated capacity of this unit was 2,100 gal. per minute against a 300-ft. head; the suction lift was 8 ft. From the pump a 12-in. welded discharge line was extended down stream to the heel of the dam and divided into two lines carried on wooden trestles near the line of the upstream face. Valves were installed at the pump and nozzles, and a telephone line was provided to facilitate regulation.

The 6-in. monitor was of standard ball-and-socket joint type and was provided with nozzle sizes of 2½, 3 and 4 in. The monitor was counterweighted with rock and controlled by one man. Pressure gages were installed at the nozzles. Four set-ups were made, there being only one monitor in use at a time.

In general, sluicing operations started with a 2½-in. nozzle, with pressures of 175 to 185 lb. per sq.in. to provide cutting and loosening power. Later 4- and 6-in. nozzles were inserted, with pressures of 30 to 5 lb. per sq.in. for washing down. The earth and loose rock yielded readily to the jet, and the greater part of the material removed at each set-up came off during the first few hours of sluicing.

The left abutment is a relatively plane area with a slope from streambed to crest averaging 0.85 to 1. During the first 24 hours sluicing was at a rate of nearly 200 cu.yd. per hour. Another 22 hours was required to sluice down to streambed the loosened material and cut out the larger pieces.

The general shape of the right abutment, viewed in plan, is convex, projecting into the streambed with an average slope from streambed to dam crest of 1.06 to 1. Sluicing was consequently much slower than on the left abutment because of the flatter slope. On this abutment the material tended to hang up on the benches, requiring some hand work in getting the material to the point where it could be washed into streambed. Water tended to wash out the fine material, requiring barring and loosening of the heavier masses.

Results accomplished to May 31, when practically all the rough sluicing had been completed, included removal of 23,000 cu.yd. of material from the right abutment, with 152.6 acre-ft. of water, giving a volumetric ratio of water used to material washed down of 10.7 to 1. On the left abutment 5,000 cu.yd. was removed, with 21.5 acre-ft. of water giving a volumetric ratio of 6.9 to 1.

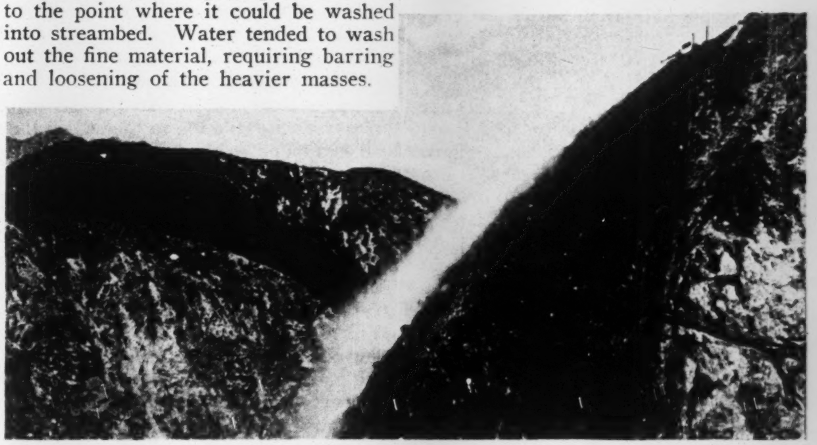
A total of 198 hours with the cutting nozzles was required to loosen the 28,000 cu.,yd. of overburden. The remaining 186 hours of sluicing was required to wash down the loosened material with the larger nozzles.

The maximum rate of removal was 300 cu.yd. per hour; the average loosening rate with cutting nozzles was 140 cu.yd. per hour, and the average sluicing for both operations was 73 cu.yd. per hour.

At each set-up the jet was used tangentially to the mass to be moved. The maximum distance measured radially from the monitor to the farthest point reached by the jet was 250 ft. This was, of course, with the smallest nozzle and the maximum pressure. Nozzle pressure used depended principally upon the radius of operations desired, and the size of the nozzle depended upon the cutting power needed for dislodging masses.

The effectiveness of the sluicing method, of course, depends upon the steepness of the slope. Loose rock and earth on a steep slope such as the left abutment may be removed at an average rate of 200 to 300 yd. per hour. Where slopes are steep enough to permit of sluicing, it constitutes an ideal method for exploration and exposure of geological formations.

K. J. Harrison is resident engineer on the work, which has been contracted to Macco-Lewis, Inc., Clearwater, Calif.



Monitor set up on right abutment of dam is sluicing rock and loose material into canyon below. A 2½-in. nozzle, with pressures up to 185 lb., was used for cutting, while pressures as low as 5 lb., with a 4- or 6-in. nozzle, were adequate for washing the material down.

Welded Joints for Seismic Stresses in a Tall Building

A discussion of the efficiency and economy obtained in the thirteen-story office building of the Southern California Edison Co. in Los Angeles—Comparisons with riveted designs

By H. H. Tracy

Structural Engineer, Southern California Edison Co. Ltd., Los Angeles, Calif.

AN IMPORTANT feature of welded joints in structural-steel assemblages is that they may be made more compact than riveted joints of equal capacity. Welded joints in general can also be made more rigid than riveted joints. Advantage of these two characteristics of welded joints was taken in the design of the thirteen-story office building of the Southern California Edison Co. in Los Angeles, when it was determined to proportion the structure to resist earthquake forces as well as dead, live and wind loads. The following article is a brief of a paper that was awarded third prize in the second arc-welding prize competition sponsored by the Lincoln Electric Co., Cleveland, Ohio, The author's enthusiasm for welding is obvious, so that the comparative figures of weights and costs of welded and riveted designs are probably as favorable to welding as they can be. Nevertheless, the data given should command study and attention, for they concern a problem that will recur as tall buildings are built in locations where lateral forces, whether from earthquake or wind, are important.
—EDITOR.

THE SEISMIC design of the new office building of the Southern California Edison Co., in Los Angeles, presented structural problems of unprecedented character. Although several buildings in Japan had been designed to resist seismic stresses, they were not more than six stories in height and therefore not comparable to the thirteen-story Edison building. The riveted construction of these Japanese buildings required large members and cumbersome connections. By the application of arc welding the seismic design of the Edison building was not only successfully accomplished, but the resulting steel frame with its rigid connections and bracing was but slightly heavier and very little more cumbersome than would have been the case had the standard riveted design been used, with the resulting relatively flexible frame.

At the time that the design of this building was carried out, the building code of the city of Los Angeles did not permit dead or live floor or roof loads to be supported by welded connections. For this reason it was necessary to use riveted beam-to-column connections and riveted column splices, in addition to the welded seismic connections. As the welded beam-to-column moment connections were much stronger than these riveted connections, practically all of the rivets used in the building could have been omitted without in any way impairing the strength of the structure. Moreover, due to the inevitable flexibility of riveted connections, it would be necessary for the welded connection to fail before any appreciable load would be taken by the riveted connection.

The total seismic shear at each floor is shown on Fig. 2 and is based upon Newton's law. These shears were resisted by two general types of design: interior rigid frames formed by welded beam-to-column connections, and framed portals located in exterior walls and solid interior walls.

A typical welded beam-to-column connection is shown in Fig. 3. The simplicity of this connection is evident, particularly in view of the fact that it develops the full strength of the beam. The plates connecting the beams to the column webs also serve as continuity plates to transmit stresses between column-flange beam-connection plates. The lower plate in the web connection was shop-welded, reducing field overhead welding to a minimum. In the heavier connections in the lower floors of the building the small 1-in. triangular plate was used to provide a means for obtaining sufficient weld. As this plate is on the center of the column, the stress transmitted by it goes directly through the column web, thus avoiding excessive stresses in continuity plates. The standard web connection shown is the riveted connection required by the building code to carry dead and live floor loads. Due to the relative flexibility of this type of connection a special design had to be adopted to assure the load being carried by the riveted connection and not by the welded seismic connection. Referring to Fig. 3, the lower welded connection plate is located $\frac{1}{8}$-in. below the beam flange, and the welding between the plate and beam is terminated 4 in. from the column flange. The welding on the top plate is also terminated some distance from the column, so that when the load is applied to the beam it may drop sufficiently to cause the riveted connection to absorb the load.

The horizontal forces that portal frames (K-braces) were required to resist range as high as 332,000 lb. on the lower floors. The magnitude of the stresses in the members of this portal indicate the difficulties that would have been encountered in attempting riveted design. In the case of most of the web members sufficient room between chords was not available for the placing of the required number of rivets. In the case of the kneebraces, gusset plates of such a size would have been required as to encroach upon window openings. In addition to these difficulties, practically all members would have had to be increased materially to maintain net sections, due to rivet-hole deductions.

Even with the welded design it was necessary in many cases on the lower floors to use plate girders instead of framed portals. For many of the plate girders moment connections to columns were required, which it would have been impossible in the room available to design for the use of rivets. Moments in excess of 600,000 ft.-lb. were developed by the use of more than 80 lin.-in. of $\frac{3}{8}$-in. fillet weld.

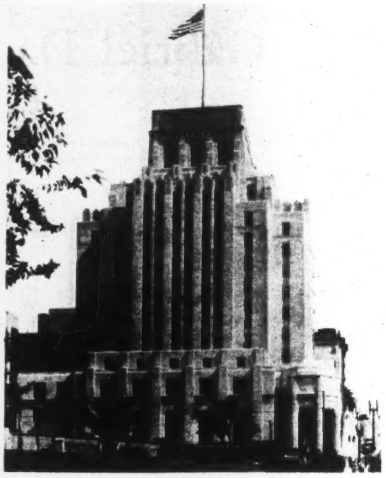


Fig. 1—The steel frame of this thirteen-story building was designed to resist earthquake forces, welded joints being used. Riveted connections, as required by the building code, carry the vertical live and dead loads.

The large column direct stresses induced by seismic forces required that coverplates be used on certain interior columns at the lower floors. These columns were 16 in. x 363 lb. H-sections, and one 18 x $1\frac{1}{4}$-in. coverplate was applied to each flange. Riveted fabrication for these members would have necessitated drilling the $2\frac{7}{16}$-in. flange of the columns, but with welding this slow and expensive operation was eliminated.

The actual weight of the welded steel frame and the estimated weight of a standard non-seismic riveted design may be compared as follows:

	Welded Seismic Design, Tons	Riveted Non-Seismic Design, Tons
Columns	1,387	1,318
Column connections	248	235
Grillage	27	27
Base slabs	140	133
Beams	1,019	917
Beam connections	192	64
Portal trusses (also serve as spandrel beams)	524	262
Total	3,537	2,956

The riveted steel frame of the building was **furnished and erected at a** price per **ton of $96.50, and all welding** was **done at an additional cost on** a time **and material** basis.

Cost per ton, not including welding	$341,320.00—	$96.50
Cost of welding, per ton	80,290.00—	22.70
Total cost per ton	$421,610.00—	$119.20

The cost of the standard non-seismic riveted design at $100 per ton would have been $295,600, so that the increase in cost due to welded seismic design was $126,010, or 42.6 per cent. It is pertinent to point out that this increase in cost is excessive by the amount of the cost of unnecessary connections imposed by the building code. The actual ton price of steel with welded construction should be no more than with riveted construction. Assuming, as above, that this price is $100 per ton, the cost of the arc-welded seismic design should be 3,537x100, or $353,700, which is $58,100, or 19.7 per cent more than the cost of the non-seismic riveted design.

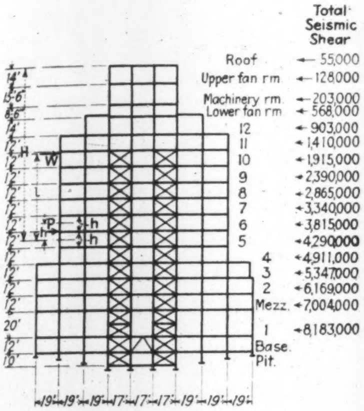
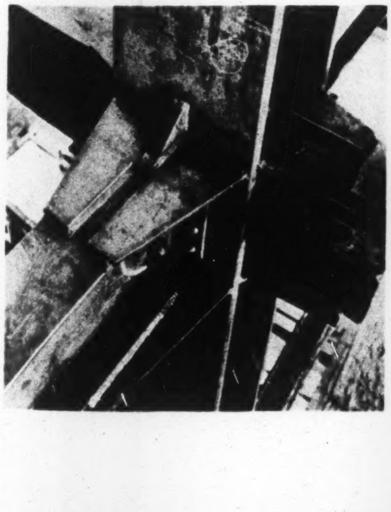


Fig. 2—Seismic shears for each floor used in the design of the Southern California Edison Co. building in Los Angeles

Fig. 3—Typical welded beam-to-column connection in Southern California Edison building. The riveted web connection shown is required by the building code.



The following estimates have been prepared to compare the weight and cost of a riveted frame designed for the same conditions as an arc-welded frame. It should be noted at the same time that many features necessary for a satisfactory seismic design of a building of this height would be exceedingly difficult and in some cases practically impossible to obtain without arc welding.

A comparison of the costs of welded and riveted designs follows:

	Tons	Cost per Ton	Total Cost	Per Cent Increase
Non-seismic riveted design	2,956	$100	$295,600	....
Welded seismic design	3,537	100	353,700	....
Riveted seismic design	4,481	100	448,100	....
Increase—welded seismic over riveted non-seismic design	581	100	58,100	19.6
Increase — riveted seismic over riveted non-seismic design	1,525	100	152,500	51.6
Increase — riveted seismic over welded seismic design	944	100	94,400	26.7

In addition to these direct savings, there is a considerable floor area made available by using a welded design. For the entire building this would amount to about 6,300 sq.ft. As a building is erected primarily for the purpose of providing floor space, and as this building cost about $15 per square foot, the welded design caused a saving in floor area of $15x6,300 or $94,500.

WEIGHT COMPARISON OF BEAMS. TRUSSES AND CONNECTIONS FOR WELDED AND RIVETED SEISMIC DESIGNS

Beam	Welded Seismic Design, Tons	Riveted Seismic Design, Tons	Increase Riveted Over Welded, Tons	Cost of Increase Riveted, Over Welded
Connections	192	801	609	$60,900
Beams	1,019	1,223	204	20,400
Trusses	524	655	131	13,100
Total increase			944	$94,400

No addition to column steel is assumed. although column net sections to resist bending would be considerably reduced by riveted connections.

The total savings made possible by an arc-welded seismic design over a riveted seismic design may be summed up as follows:

Direct saving in steel tonnage	$94,400
Indirect saving in floor area	94,500

A direct comparison of the costs of welded and riveted seismic designs is as follows:

Increase in cost of welded seismic design over riveted non-seismic design	$58,100
Increase in cost of riveted seismic design over riveted non-seismic design, including indirect costs	247,000

The increase in cost due to seismic design would, in the case of riveted construction, be 2.62 times that of welded construction, providing only direct costs were considered, and 4.25 times the welded cost if indirect costs were included.

Analyzing Hydraulic Models for Effects of Distortion

Relation of dimensions in open-channel models important in interpreting results—Results of study on free-overfall model

By **Morrough P. O'Brien**

Associate Professor of Mechcanical Engineering, University of California, Berkeley, Calif.

IN MANY of the open-channel problems in hydraulics, the horizontal dimensions involved are determined by the vertical dimensions, and this condition eliminates the possibility of using distorted models for studying such phenomena, except under very unusual circumstances. Drawdown and backwater curves, standing waves, surges, oscillatory waves, spillway discharge and all problems involving appreciable surface effects are in this class, and yet distorted models are being used to predict the hydraulic characteristics of prototypes in which these phenomena are of primary importance. The amount of error depends upon the degree of distortion and the variables involved. This limitation of the use of distorted models appears to be overlooked generally in the usual discussion of the model theory.

Free overfall

An interesting but little-known phenomena, in which horizontal and vertical dimensions are definitely related, is the free overfall at the end of a horizontal channel. So many erroneous statements on this subject are to be found in the literature on open-channel flow that it was made the subject of thesis study at the University of California during the past year to determine the relation between depth at the end and discharge per unit width of channel, as well as the surface and pressure curves. The purpose of the experiments was to show that the critical depth does not occur at the end of the channel as some writers state. The reason for this apparent discrepancy between theory and practice is that the usual treatment of non-uniform flow assumes that the pressure head at the bottom of the channel corresponds to the depth. This is not even approximately true in the case of a free overfall.

Referring to Fig. 1, the horizontal hydrostatic thrust toward the right at (1) is $\gamma \frac{b}{2} y_o^2$, and the momentum carried across this section in unit time is

$\gamma \frac{b}{g} y_c v_c^2$, assuming that the velocity distribution is uniform. The pressure at section (2) is approximately atmospheric at all depths, and the momentum carried past this section in unit time is $\gamma \frac{b}{g} y_e v_e^2$. Equating the hydrostatic forces and momenta at the two sections and canceling common terms gives

$$\frac{y_c^2}{2} + y_c \frac{v_c^2}{g} = y_e \frac{v_e^2}{g} \qquad (1)$$

This equation is applicable to a reach near the end of the channel in which the friction is negligible. Denoting the discharge per unit width of channel by q, the continuity equation is

$$q = y_c v_c = y_e v_e \qquad (2)$$

Assuming that section (1) is taken at the critical depth as usually computed,

$$y_c = \frac{2}{3} H \quad ; \quad \frac{v_c^2}{2g} = \frac{H}{3} \qquad (3)$$

Substituting equations (2) and (3) in (1) and simplifying,

$$y_e = 0.444\ H = 0.667\ y_c. \qquad (4)$$

Experiments on the relation between end depth and discharge per unit width gave

$$q = 11.0\ y_e^{1.61} \qquad (5)$$

The equation for the critical depth in a uniform channel is

$$y_c = \sqrt[3]{\frac{q^2}{g}} \qquad (6)$$

and substituting (5) in (6) gives

$$y_c = \sqrt[3]{\frac{121\ y_e^{3.22}}{g}}$$

making $y_e = 1$, $y_c = 1.55$ and $\frac{y_e}{y_c} =$ 0.643, as compared with 0.667 given by the momentum equation (4). The exponent of y_e in equation (5) should be 1.5 to correspond with theory, and the difference indicates the effect of friction as well as the experimental error.

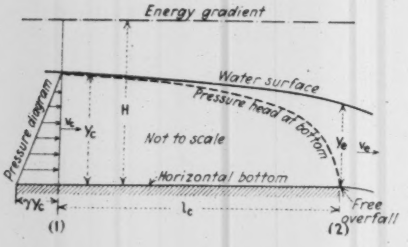


Fig. 1—Sketch illustrating relation of end depth, discharge and pressure on model of free-overfall channel. In the actual model test the relation of pressure curve to surface curve was about as shown; and the distance l_o to the point at which they coincided, was three times the end depth y_e.

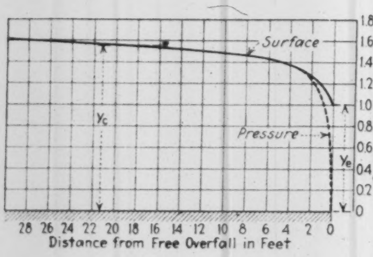


Fig. 2—Point of critical depth occurs a distance of 18 times the end depth back of the overfall point, or 11.6 times the critical depth.

In Fig. 2, showing the measured surface and pressure curves, the critical depth occurs at a distance from the end of the channel equal to 18 times the end depth, or 11.6 times the critical depth. The pressure head at the bottom differs from the depth by an appreciable amount over a distance equal to 3 times the end depth (Fig. 1). The important point to be noted is that the horizontal coordinates as well as the vertical are completely known as soon as the depth y_e is specified. In other words, in making a model that involves this phenomenon, as in the case of a spillway or broad-crested weir, the horizontal and vertical scale ratios must be equal, and any distortion eliminates the possibility of tranferring the model results to the prototype.

Although the length of the hydraulic jump has not been correlated precisely with the initial velocity and depth, it has been variously estimated as between 5 and 12 times the vertical rise. Whatever the precise relationship may be, it is generally agreed that the length depends upon the ratio of the final to initial depth, which in turn is a function of $\frac{v_1^2}{2gy_1}$, where v_1 and y_1 are the velocity and depth before the jump, respectively. Since v_1 and y_1 are both dependent upon the vertical scale ratio in transferring results from model to prototype, it is evident that, in models involving the hydraulic jump, distortion of the model is not permissible.

Non-uniform steady flow

The general equation of non-uniform steady flow in open channels is

$$\Delta h = Q^2 \left(\frac{1}{C^2\ Ra^2} - \frac{2b}{a^3} \right) \Delta x \qquad (7)$$

where h is the elevation of the water surface above a horizontal reference plane, Q is the discharge, C is the coefficient in the Chezy formula, a is the area, b is the surface width, and x is the length along the channel. This equation must apply to both model and prototype. Indicating the vertical scale ratio by n and the horizontal by m and assuming that the hydraulic radius follows the vertical scale ratio, the equation for the model, corresponding to (7), is

$$n\Delta h = m^2 n^3 Q^2 \left[\frac{1}{C^2 . n R . m^2 n^2 a^2} - \frac{2mb}{m^3 n^3 a^3} \right] m\Delta x$$

$$= m Q^2 \left[\frac{1}{C^2\ Ra^2} - \frac{2b}{a^3} \right] \Delta x \qquad (7a)$$

Dividing (7a) by (7), $n = m$. Since equation (7) applies to all drawdown and backwater curves where the pressure head at the bottom equals the depth, the above requirement that the horizontal and vertical scale ratios be equal eliminates the possibility of using distorted models in studying such phenomena. The backwater effect of dams and cutoffs at river bends both come under this classification.

The foregoing three examples illustrate the conditions that tend to eliminate distorted models as a means of studying open channel problems. The backwater and other surface effects cannot be distorted at will and, if the boundaries of the model are constructed to different horizontal and vertical scales, the data obtained from the model regarding the surface and pressure curves, velocities and discharges cannot be increased by the usual scale factors to give the corresponding quantities in the prototype. The magnitude of the error introduced will depend upon the configuration of the model, the degree of distortion and the particular variable being studied. Although these factors may have been small in the distorted models that have been used, there is no theoretical justification for their use.

As an example of the error involved, the free overfall described previously will be assumed to form a part of a model of a hydraulic structure that has been reproduced with the horizontal dimensions reduced twice as much as the vertical dimensions. The critical depth in the model is observed at a distance from the end equal to 18 y_e, and if these data are now transferred according to the scale ratio, the critical depth should occur at 36 y_e in the prototype, a manifest absurdity. The same is true of the hydraulic jump at the foot of a spillway. If a distorted model is built to determine the scouring conditions and the necessary length of the apron, the horizontal dimensions will be fixed by the vertical dimensions, regardless of what distortion is assumed, and in the usual case of a greater reduction horizontally than vertically, the length of the apron in the prototype will be greater than necessary.

The same reasoning applies to the discharge from sluice gates, since the flow below a gate is non-uniform and follows equation (7). In one recent test on a distorted model of a dam for river control, a circular sector gate was reproduced with an elliptical surface. The absurdity of this procedure is evident when it is considered that with a very great distortion, a circular surface becomes planar and the approach conditions are completely altered. In the extreme case an ogee spillway section becomes a sharp-crested weir from which the nappe would spring free.

In some river models used to determine backwater effects a distortion ratio of as much as 10 has been used, and it is very doubtful if the results have any significance at all. The model probably agrees with the prototype at controlling sections such as rapids and narrows, but at all other points the depths predicted from the model would be less than observed in the river. The error is probably small and grows less as the frictional forces in the channel increase in importance.

Distorted models have been used to avoid viscous flow in the model and to maintain velocities capable of moving sediment, but in using such models experimenters appear to have lost sight of the fact that in most cases of open-channel flow the vertical and horizontal dimensions are related and distortion is theoretically not permissible. It remains for experiment to show how far distortion can be carried in river models without leading to grossly erroneous results in essential features.

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Test on Sludge Beds Show Best Drying Depth

Studies at Schenectady indicate that greatest production of dried sludge per unit area of bed will be obtained with a 10-in. depth when rate of removal is taken into consideration

By Morris M. Cohn
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AS THE RESULT of a study of sludge drying carried out at the sewage-treatment plant at Schenectady, N. Y., it has been determined that if digested sludge from the Imhoff tanks is drawn onto the beds to a depth of 10 in., under average Schenectady conditions there will be produced the greatest amount of dried sludge per unit of bed area at the lowest labor cost for removal.

The sludge beds consist of one battery of eight drying units, each 159x19 ft., separated by wooden partitions. The sludge enters these beds through piping assemblies located at the center line of each bed and flows both ways to the ends. The beds are composed of the usual sand-gravel-underdrain construction, laid directly on clay excavation. Another battery of drying beds consists of an area 142x97 ft., divided into two sections by a clay puddle wall. These beds are filled from end gates. The total bed area at Schenectady amounts to 0.87 acres, equivalent to 0.57 sq.ft. per capita served by the plant.

The meager provisions for sludge drying, coupled with the scant sludge and scum provisions in the tanks and the troublesome scum-forming tendencies of the tanks, place the Schenectady works in a difficult position on the matter of sludge drawing and drying. Sludge removal from the tanks is usually started in May and continues at as rapid a rate as possible until the early part of November. As little sludge as possible is left in the tanks at the start of the winter storage period.

The sludge-drying study to be described was carried out for the purpose of determining what depth of drawing onto the Schenectady beds of average Schenectady sludge under average Schenectady weather (the Schenectady bed-cleaning program being considered), would utilize the beds most efficiently.

Four sludge beds were prepared for drawing and carefully raked. The gas vents of the tanks were thoroughly hosed to assure a sufficient supply of sludge. Twenty-four hours later the sludge was pumped to all four beds simultaneously. One bed was dosed to a depth of 6 in., one to 8 in., another to 10 in. and the last to 12 in.

Samples of wet sludge were composited from each bed, as the sludge poured from the inlet pipe into the diversion box. Some variation in sludge moisture content was noted from bed to bed, in spite of the simultaneous pumping. At 24-hour intervals after the drawings, composite samples of the drying sludge were taken from the four beds, the samples being made up of portions taken from six sampling spots along the bed lengths. The sludge was thoroughly stirred at the sampling points in order to assure the mixture of the top gas-lifted solids with the thin liquor below. Careful observations were made of such phenomena as cracking, shrinkage and color changes. Records were maintained of atmospheric temperatures, weather condition, rainfall and wind movement during the days of drying.

When the sludge reached a moisture content of 65 per cent or slightly less, the sludge was considered ready for removal. The 6-in. bed dried down to a 2-in. cake in seven days, the 8-in. bed produced a 2½-in. cake in eight days, the 10-in. bed shrank to a 3½-in. cake in twelve days, while the 12-in. bed required nineteen days to dry down to a 4½-in. deposit. The dried sludge was removed as soon as ready, accurate observations being made of the time required to remove the sludge, of the handling methods used by the laborers and of the amount of sand removed with each cleaning. The information gained was used to compute the theoretically ideal depth to which sludge should be drawn to the Schenectady beds.

Since the 6-in. bed produced a 2-in. cake in seven days, the drawing yielded 0.286 in. of dry cake per day, or 23.8 cu.ft. of dry sludge per 1,000 sq.ft. of bed area daily. Similarly, the 8-in. bed produced dry sludge at the rate of 0.312 in. a day, or 26.0 cu.ft. of dry sludge per 1,000 sq.ft. of bed area per day. The 10-in. bed provided a 3½-in. cake in twelve days at a production rate of 0.292 in. of dry sludge per day, or 24.3 cu.ft. of dry sludge per 1,000 sq.ft. per day.

The 12-in. bed produced 0.237 in. of dry sludge per day, or 19.8 cu.ft. of sludge cake per 1,000 sq.ft. of bed area daily.

On the basis of these computations it appeared that the most use could be made of the beds if sludge was drawn to the depth of 8 in. The second most efficient depth was apparently 10 in., while the other depths were much less economical. But, sludge drying is not the final installment in the story of sludge disposal. The dried cake must be removed, and the beds must be prepared for additional sludge. In view of this fact, it appeared that the theoretical computation of bed productiveness could not be used, in itself alone, to

Sludge is removed from the beds with six-tine manure forks and loaded into 1-cu.yd. cars. The cars are moved by hand. All the sludge is sold for fertilizer.

determine the ideal bed-handling procedure.

The time studies indicated that the rate of removing 2-in. cake was slower than for clearing an equal volume of 2½-in. cake. Similarly, 3-in. cake was removed, yard for yard, at a more rapid rate than 2½-in. cake. On the other hand, the 4½-in. was removed at approximately the same rate as the 3½-in. deposit. The differences in cleaning rate were caused by the fact that the thinner cakes required more fork action per yard of removal than the heavier cake and required more car shiftings by the men. The 4½-in. cake appeared somewhat heavy for the cleaning crew as the day wore along, and often required cutting into chunks with a shovel.

A more detailed study was made to determine the speed of removal of 2½- and 3½-in. cake from the beds. It was found that a cleaning crew of two men working a full day, supplemented by a third man assisting them for a half day, removed 2½-in. cake at the rate of 35 cu.yd. per day and 3½-in. cake at a rate of 40 cu.yd. per day. These figures are averages of many days' observations. It is important in every case under observation that the heavier cake be removed more rapidly than the thinner. The rates are dependent on many personal factors and cannot be used too literally. They merely provide the comparative bases for the time-study computations.

Schenectady labor practice at the sewage works results in 1½ days of unproductiveness per week on the sludge beds. The laborers have Saturday afternoon and Sunday off, plant operation being maintained by a skeleton crew, with no bed cleaning undertaken except in cases of emergency. This results in 5½ cleaning days in each seven. For the 2½-in. cake the corrected daily removal becomes 35 cu.yd. multiplied by 5.5 and divided by 7, or 27.5 cu.yd per day. For the 3½-in. cake the corrected daily removal amounts to 31.4 cu.yd.

The Schenectady beds have an area of 37,897 sq.ft. With the area of the particular bed under consideration deducted from the total area, an area of 34,771 sq.ft. of bed space must be cleaned before the cleaning crew returns to each bed after it has been drawn.

With a 2½-in. cake, resulting from an 8-in. drawing, the total volume of sludge to be removed between the intervals of drawing sludge to a bed and returning to it for cleaning is 7,232 cu.ft., or 268 cu.yd. At the corrected rate of removal of 2½-in. cake of 27.5 cu.yd. daily the removal of this sludge would require 9.7 days. Since the sludge was ready for removal in eight days, 1.7 days of non-production would be charged up against the bed. This would not be ideal handling. For example, the period of unproductiveness would reduce the rate of dry-sludge production to 21.5 cu.ft. daily per 1,000 sq.ft. of bed area, insteady of 26.0 cu.ft.

Considering the 3½-in. cake resulting from the 10-in. drawing, in similar analytical fashion it will be seen that the beds to be cleaned would hold 376 cu.yd. of this thickness cake. At the corrected rate of removal of 31.4 cu.yd. daily it would require exactly twelve days to return to each bed for cleaning. It is a coincidence that the rate of drying during the test provided just this drying period for the depth of drawing in question. The rate of dry-sludge production thus remains 24.3 cu.ft. per 1,000 sq.ft. of bed area daily as theoretically computed. This stands out as the most productive true rate possible for the depths of sludge tested.

Judging from the experimental findings, drawings of 6-, 8- or 12-in. depths would be uneconomical under Schenectady conditions tested. The 10-in. bed has proven satisfactory as routine practice during the major part of the summer. It is reasonable to recognize that the depths of drawings are varied during the early spring months of slower drying, the last fall months of similar poor dewatering weather and during such times in mid-summer as it is planned to change the labor policy on the sludge beds.

The parallel tests disclosed many interesting phenomena of drying sludge. The 6-, 8- and 10-in. beds showed surface cracks within 24 hours after drawing, while the 12-in. bed remained unbroken until 48 hours.

The most rapid reduction in moisture content came, naturally, during the first 24 hours, when all of the beds lost more than 30 per cent of the total water removed during the entire drying periods. The sludge solids rose rapidly to the top of the beds after drawing, and the beds showed increase in volume for several hours. It was not until the end of the third day that the absence of underwater was noticed on the beds. From then on the rate of drying was slow. The 6-in. bed dried rapidly, and consistently had less moisture than the other beds. The 8- and 10-in. beds remained about the same until the sixth day. The deepest bed was consistently wetter than the other beds, and the difference increased as the days passed.

The first light sprinkle of rain came on the second day and had no effect on the drying progress. A ¾-in. rain on the third day came after the sludge sampling for that day had been taken but showed up on the next samples. The retarding of drying was especially noticeable on the 12-in. bed. A ¼-in. rain on the sixth day increased the moisture content of the 12-in. bed but had no effect on the other beds, which had already cracked clear down to the sand.

It can be concluded that the rains had greater effect on the heavier bed until that bed had cracked throughout its entire depth. The rains did increase the moisture content of all beds for a short time after the storms. The spongy sludge cakes recovered their original character quickly. Heavy rains appeared to beat the gas out of the sludge and caused depressions in the sludge layers, especially on the 12-in. bed.

It was found that all four thicknesses of sludge cake removed about the same amount of sand. The thinnest cake and the heaviest cake left the greatest amount of sludge residue on the beds, which had to be raked.

It is certain that the Schenectady findings will not be proved correct in other plants. It is equally certain that the methods of computation are open to some criticism. The moisture content of the sludge, the climatic conditions and the vital human factor in labor handling make the problem difficult to solve once and for all. The introduction of mechanical methods of cleaning sludge beds will reduce the effect of cleaning time, and "bed productiveness" will become the ruling factor in bed management. The important thing is that sludge beds require and are open to the same type of time studies to which mass production processes are subjected in modern industry. One swallow does not make a summer, and neither does one sludge drawing. The beds must be filled with the thought in mind of getting the sludge off in time for another filling.

TEST OF DRYING RATES OF DIFFERENT DEPTHS OF WET SLUDGE

Days Drying	Per Cent Moisture Content Depth of Sludge on Bed, In. 6	8	10	12	Temp. Air, Deg. F.	Wind	Weather	Precipitation, In.	Remarks
Drawn	95.07	95.70	94.99	95.86	65	Strong	Sun	....	....
1	83.01	84.22	84.25	85.37	61	Light	Sun	....	6, 8 and 10-in. beds cracked.
2	78.20	80.61	81.38	82.66	63	Strong	Cloud	0.02	12-in. bed cracked.
3	73.40	76.66	76.98	79.55	74	Moder.	Sun	0.76	Rain during early morning.
4	71.08	74.87	75.63	79.40	63	Moder.	Sun	....	....
5	67.20	72.07	72.40	77.42	62	Moder.	Sun	....	....
6	66.00	69.70	70.10	75.23	63	Light	Cloud	0.26	....
7	64.87	66.33	69.68	75.70	57	Strong	Sun	....	6-in. bed dried to 2 in. and was removed.
8	....	64.69	68.90	73.81	60	Moder.	Sun	....	8-in. bed dried to 2½ in. and was removed.
9	....	....	67.40	72.50	59	Moder.	Sun	....	....
10	....	....	66.86	71.70	59	Light	Sun	....	....
11	....	....	66.04	71.03	64	Light	Sun	....	....
12	....	....	65.00	70.20	61	Light	Sun	....	10-in. bed dried to 3½ in. and was removed.
13	....	....	....	69.90	61	Light	Sun	....	....
14	....	....	....	69.03	64	Light	Cloud	0.01	....
15	....	....	....	68.52	66	Light	Cloud	....	....
16	....	....	....	68.04	65	Light	Sun	..	....
17	....	....	....	67.24	67	Light	Cloud	0.06	....
18	....	....	....	66.88	69	Light	Cloud	0.20	....
19	....	....	....	64.92	57	Light	Cloud	0.07	12-in. bed dried to 4½ in. and was removed.

The Elevator Problem of the Tower Building

First of two articles discussing some methods of saving time and space in vertical transportation in the super-skyscraper

By Carl F. Scott
New York, N. Y.

In THE construction of tower buildings, such as those that have been erected in New York and elsewhere in recent years, a very real problem has been presented in getting in enough elevators to give adequate service without allowing the total cost to run so high as to imperil the return on the investment. A discussion of these problems is appropriate now in order that they may be thoroughly appreciated when the construction industry takes its upward turn.

The problem is a pyramid of difficulties. The taller the building the longer the run and the longer the round-trip time; the longer the round-trip time the more elevators are needed to keep the intervals between departures and the number of passengers in unit time to a point acceptable to the tenants and users. But the more elevators the more space they take from the net rental area. In either case the elevator cost and the first cost of the building is increased and the rental revenue diminished at the same time. This places a very real limitation on the economical height of buildings.

The fact that buildings like the Empire State, Chrysler and others that are familiar to everyone have been put up would seem to indicate that the problem has its solution. Actually the more recent and more economical solutions have not been applied to these buildings, which were erected in spite of the obstacles presented by the elevator problem and today face a greater or less burden of excessive elevator-plant investment.

Solving the problem

There are a number of solutions of the problem. Some of them are in practical demonstration today. One of them, the double-deck elevator, has been put to commercial service by installation in the new 66-story building in New York known as the Sixty Wall Tower. Another, the operation of two elevators in one hoistway, is in regular service in the office building of the Westinghouse Electric & Manufacturing Co., at East Pittsburgh. Other practicable solutions are still in the paper stage. Some seem like dreams but, by all human experience, these dreams are likely to be realized.

In a second article these various solutions will be described in detail. The present article attempts to show the nature of the problem, the factors involved in considering it and their economical significance.

Limitations of speed

Since the problem of either installing enough elevators or getting along with as few as possible depends on how short the round-trip time of an elevator can be made, the man in the street naturally wonders whether the practicable limits of elevator speed have been reached. While it is dangerous to say that the limit of anything mechanical has been reached when tomorrow may open the door to a wider and higher limit, yet with the present-day speeds of 900 to 1,200 ft. per minute the gain from further increase promises to be small compared with the gains resulting from other methods of increasing the elevator service per unit of floor space consumed.

It should be recognized that the time it takes an elevator to make a round trip depends quite as much, often more, on the time lost in making stops as it does on the linear velocity. In accelerating and retarding there are definite limits, based on human comfort and on the economical relationship between accelerating torque, rope slippage and running torque. In getting doors open and closed there are definite limits based on the masses moved and considerations of safety. A large part of the effort of elevator engineers in the past decade has been directed toward reducing to a minimum the time lost at each stop of an elevator and eliminating unnecessary stops.

A speed of 1,200 ft. per minute, or 14 miles per hour, brings no discomfort in itself, but it involves a change of level of 1,000 ft. in a minute or less, which means a change in atmospheric pressure of more than 1 in. of mercury, enough to be felt as a discomfort by many people. The high-rise cars in the Empire State Building, running to the 80th floor, are operated now at 1,000 ft. per minute but have machinery large enough for a speed of 1,200. The high-rise cars in the 69-story building in Rockefeller Center (Radio City) are to run at 1,200. It may be noted, as showing how little gain there is for a speed of 1,200 over a speed of 1,000 in this building, that the increase of 20 per cent in linear velocity reduces the round-trip time by only 6 per cent. But the summation of a number of such savings makes efforts to improve elevator service worth while.

Passenger habits

One of the most difficult factors to control, of those making up round-trip time, is the time for passenger movement. Various devices have been resorted to for cajoling people into stepping in and out of an elevator faster, such as wider doors, wider cars, level stops, proper grouping of cars, audible as well as visible signals to bring passengers to the hoistway door before the car stops there, directional signs in the lobby, polite encouragement by the starter and the operators, etc. Much of course depends on human habits, which vary with locality and occupation.

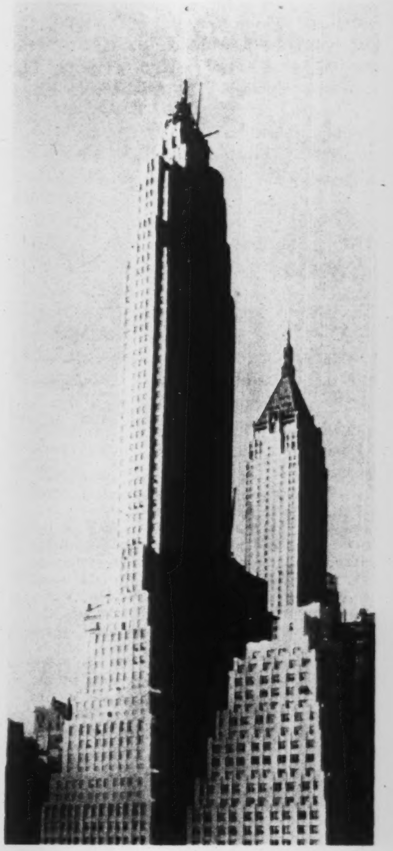


Fig. 1—In the 66-story Sixty Wall Tower, New York, double-deck elevators were adopted as the economical method of serving the tower. With single-deck elevators a height of 48 stories would have been the economical limit. Architects were Clinton & Russell, Holton & George. Builders were James Stewart & Co.

This matter of elevator habits is of great importance in any of the schemes adopted for the solution of the elevator problem. Fear of adverse reaction from even a small change in habits, while these old habits can be indulged in an older building, has held back progressive developments in new ones. If certain habits could be easily changed without fear of competition such, for example, as the reluctance to walk up or down one flight of stairs or change cars, elevator plants might be made more economical and would render better overall service.

Signal operation to gain speed

The development of signal control, more properly called *signal operation,* and often called *full-automatic operation,* has been an important contribution to the gain in speed and consequent saving in space. This is the system in which the operator starts the car but the passenger, in effect, stops it. You press a button in the hallway and the next approaching car stops automatically at your floor. When you get aboard, the same process ensues, except that the operator presses the button for you. The car levels automatically when it stops. and the doors are automatically opened. The doors close when the operator moves his lever to start the car.

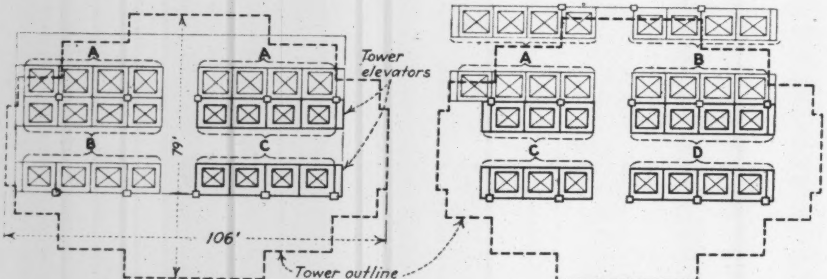


Fig.2

Fig.3

Figs. 2 and 3—Effect of double-deck elevators in tower-plan arrangement of Sixty Wall Tower. Fig. 2 shows elevators as installed. The dashed outline is that of the tower, but the elevator plan is drawn for the ground floor. Bank *A* takes out space to the 18th story, bank *B* to the 31st story and bank *C* to the 62nd story. Fig. 3 is a single-deck layout. Compare the tower elevators, shown by heavy full lines, with those of Fig. 2. In this layout bank *C* would serve from the 31st to the 46th floors, and bank *D* from the 46th to the 60th. The tower floors 31 to 46 would have very little rental space left. The layout shown is not the only one possible.

An elevator can scarcely be operated successfully at speeds above 700 ft. per minute without signal operation, as the operator cannot make the landings without loss of time. Signal operation not only permits of high speed but it gives greater safety; 80 per cent of all fatal accidents on elevators have been landing-door accidents, and signal-operation elevators have yet to have a fatal accident.

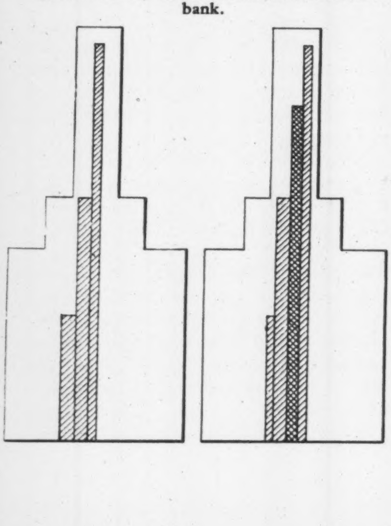
Service standards

To appreciate the elevator problem, one must know the standards of service that are considered essential today. Aside from the general standards of safety and comfort, the yardsticks by which elevator service is measured are four interdependent measures: (1) time to empty the building; (2) proportion of the total building population which can be moved during 5 min.; (3) passengers' waiting time, or the average interval of departure from the ground floor; (4) total time it takes a tenant to reach his office from the lobby floor.

The numerical value of these standards varies for different localities, different types of buildings, different occupancies, and it may be higher or lower in the future for any given conditions. Few real-estate men expect them to be any lower in new buildings that may be erected to compete with existing structures.

For an office building in a busy financial center, catering to the highest-paying tenancy, an average departure interval at the ground floor of 20 sec. is considered first-class. In some buildings the waiting time is even less. In such buildings the whole population can be cleared out in 30 to 40 min. An average departure interval of 30 sec., if maintained uniformly, seldom causes important complaints, even in first-class buildings. Intervals of 45 to 60 sec. would not be considered first-class, and longer intervals indicate under-elevatoring or improper management.

Fig. 4—Diagram of comparative space required by double-deck and single-deck elevators. Horizontal distances represent floor areas. At the left is shown the space utilization in Sixty Wall Tower with double-deck elevators in the high-rise bank. At the right, as it would have been with single-deck elevators in all banks; the cross-hatched area represents the added space taken by the elevators of the fourth bank.



Contrasted with office-building requirements are those for apartment houses, where longer waits are expected and where the tenancy moves in and out over a longer period. However, some apartment houses, such as those in the exclusive residential districts of the big cities, have a large investment in elevators and give service comparable to that of a modern office building. As an extreme of poor service may be cited the case of an apartment house with one elevator for 96 families.

There are different standards of service for different types of buildings, loft buildings, hotels, hospitals, department stores, institutions of various sorts, etc., but in these buildings the elevator problem is seldom as acute as it is in the tall office building.

Examples of service calculations

First Example—The interdependence of the various yardsticks of service may be shown by the following simple example:

A.	Average round-trip time per car (determined from the rise, speed, number of stops and loading), Sec.	150
B.	Number of cars	6
C.	Interval, A/B, Sec.	25
D.	Car departures in 5 min., 5 x 60/25	12
E.	Average no. passengers per car	14
F.	Passengers carried in 5-min. peak, 12 x 14	168
G.	If building has 1,400 persons, this is	12% in 5 min.
	or the building is emptied in	42 min.

In practice, of course, the process starts with the population and the desired standards for *G, F* and *C;* the size, speed and number of cars are calculated from these data.

Second Example—To show the effect of change of height on the selection of elevators and the economical return, assume a building for which 45 stories seems to be an economical or desirable height. Assume further that the building may have a block portion 30 stories high without setbacks, and that this portion can easily be elevatored by two banks of elevators, one serving floors 2 to 15, the other floors 15 to 30. The tower floors, 31 to 45, are to be occupied by 1,000 people, and we wish to give these tenants an interval near 25 sec. and to empty the building in 40 min. (or move one-eighth the population in 5 min.). A bank of six cars, each with a capacity of 2,500 lb., or 12 passengers, and a speed of 900 ft. per minute, would meet these standards, except that the interval would average a little more than 25 sec. But if the building were only five stories higher, these six cars would not be adequate. The added travel and the added stops would prolong the round-trip time, and with the added population to be handled the standards of service would fall to a point where it would be difficult to rent the building. One or more added elevators would increase the first cost materially, take away a good part of the space added by the five extra floors and perhaps reduce rather than diminish the return.

The elevator problem is thus seen clearly to reduce to one of getting more traffic-handling capacity out of each shaft, the possibilities of one elevator in one shaft having been pretty well exhausted. This at once suggests putting two elevators in one shaft or putting two decks on one elevator. There are other means also.

The dual elevator, which comprises two separate cars in one shaft, is distinctly new. It awaited the necessity for it on the one hand, and the development of adequate safety devices on the other; both conditions have now been met. *The double-deck elevator* is not new, for there were double-deck elevators prior to 1900, the lower compartment being used for freight. But until recently its use for passenger service has been ruled out by city regulations as unsafe. Modern methods of control have removed the hazards and have made it practicable and approved.

Double-deck elevators have been proposed for high buildings for a long time, but it remained for the H. L. Doherty Co. to do the pioneering in its home office-building in New York, Sixty Wall Tower. This engineering organization was accustomed to pioneering, the scheme seemed sound, and while the public would have to modify its habits a little the change was not to be very great. It has been stated that the reason the H. L. Doherty Co. could afford to take a chance with the new system was that their's was a one-purpose building serving their own employees, but the fact is that the part of the building served by the double-deck elevators is that offered for rent to the general public. The double-deck system or some equivalent was necessary to give adequate service in the limited area of the building.

Cost and space savings

Designed by Clinton & Russell, Holton & George, and erected by James Stewart & Co., Sixty Wall Tower is on a plot about 28,000 sq.ft. in area. Its block portion was limited by the zoning law to 30 stories. This portion could be readily served by fifteen single-deck elevators, eight of 4,500 lb. at 700 ft. per minute serving the first 16 floors, and seven of 3,000 lb. at 900 ft. per minute serving the floors from the 16th to the 30th. The low-rise bank of eight cars is helped out by escalators to the sixth floor, which is another innovation. The elevators and escalators were installed by the Otis Elevator Co.

It was estimated that with single elevators the economical height for the tower was 48 stories. But by using double-deck elevators the economical height could be raised to 60 stories, and all parts of the tower could be given good service. To give equivalent service with single-deck cars, it was estimated that six additional cars would have been needed—that is, fourteen single-deck cars in two banks instead of eight double-deck cars in one bank. The fourteen single-deck cars, including hoistways would have cost nearly $200,000 more than the double-deck cars, and with their hallways would have taken out about 40,000 sq.ft. more floor area. The double-deck cars also give added platform capacity for the top floors when it comes to clearing the building quickly at night.

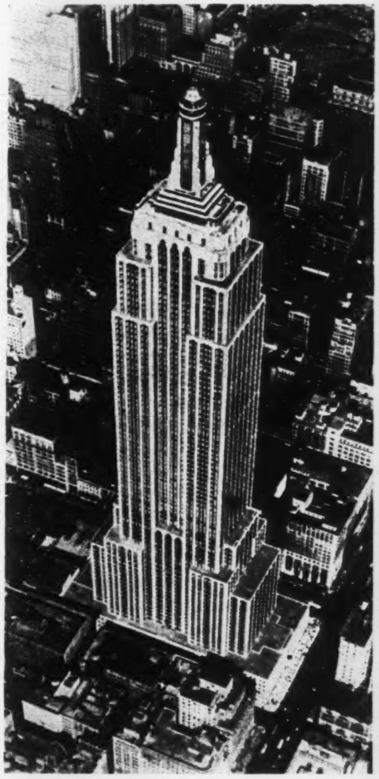


Fig. 5—The Empire State Building is distinguished by large ground area, low height of street facade (six stories) and its high tower section large enough to accommodate 36 passenger and four freight elevators. The building would have offered opportunity for a material saving in cost by use of double-deck elevators. Architects: Shreve, Lamb & Harmon. Mechanical engineers: Meyer, Strong & Jones. Builders: Starrett Bros. & Eken.

A natural question is why a building like the Empire State did not adopt either double-deck or dual elevators if there is so much to be gained. The answer lies in the reluctance to try something new and the necessity for speed in the construction work. Actually the double-deck elevator could have been installed in the Empire State, for the art was advanced far enough when the building was projected. But the building was a race against time in view of the enormous carrying charges on the large plot; the tower area was large enough to accommodate the necessary number of conventional elevators; the unique size and height of the building promised to attract tenancy and yield a return even if the building cost were made higher by sticking to conventional design; and there would be no handicap of reluctant customer acceptance to overcome.

But the savings would have been large. Empire State has a plot area of more than 83,000 sq.ft., a height (exclusive of observation tower) of 85 stories and a net rental area of about 2,150,000 sq.ft. There are 64 elevators, 58 of them arranged in seven banks for general passenger service. Floors 25 to 80 are served by 36 elevators in four banks; if it could be assumed that these 36 elevators could have been replaced by twenty double-deck elevators, there would have been a saving of nearly 200,000 sq.ft. (or more than four acres!) of net rentable area, and a saving in the cost of elevators and shaftways of nearly $400,000. There would have been a saving of some 5 per cent in the cube of the building if the added rental area were not wanted. Even if 20 double-deck cars were inadequate and 22 were required to replace the 36 (which would have meant a complete rearrangement), the gain in net rental area would have been about 130,000 sq.ft. One might go farther and picture the indirect advantages of the second loading level in the basement, with the relief of congestion in the main level and the basement concessions that might be rented.

Double-deck elevators would work out well also in the 69-story building of Rockefeller Center. There was greater reason here for making such an installation than in Empire State, because the Doherty installation bade fair to be completed nearly a year before Rockefeller Center, which is sufficient time to work out the difficulties to be expected in any new installation.

A lower size limit

With smaller buildings the savings by the use of the new systems are naturally less, but they are nevertheless important. An estimate made by H. D. James, of the Westinghouse Electric & Manufacturing Co., for a typical 50-story building on a plot of 40,000 sq.ft. showed a saving of 3.05 per cent in net rentable area, or a reduction of 2.23 per cent in the cube of the building for the same net area by the installation of dual instead of conventional single elevators.

There is of course a limit where these types should not be considered. A 27-story building that might ordinarily be elevatored by ten cars in two banks would show a small gain by the use of double-deck elevators, but a 20-story building that might require a single bank of six elevators serving all floors could not be served adequately by three dual or double-deck elevators, or even by four, as the interval would be too long and the double loading floor objectionable for so small a building.

Elevator data on recent skyscrapers

To give a concrete picture of the limitations placed on tall buildings by the elevator problem, the accompanying table has been prepared, showing the principal data on the last twelve skyscrapers 45 stories and more in height, built in New York. All these buildings are "zoning law" buildings, with a tower portion whose cross-section is about a quarter of the plot area.

One at once notices the marked difference in some buildings between the total number of stories and the highest story to which a whole bank of elveators is carried right from the lobby (col. 7), this being the highest floor enjoying really good elevator service. The average interval of departure from the ground floor of the elevators serving this level of col. 7 is shown on col. 11. This interval, which is equal to the average round-trip time per elevator divided by the number of elevators in the bank (col. 8), is calculated for maximum service conditions and for a speed of 1,000 ft. per minute except that for buildings 7 and 12 on the list the interval is based on a speed of 1,200 and for No. 9 on a speed of 800 ft. per minute.

It will be noted that this interval, as a measure of service, is quite satisfactory in most cases. The problem has been met in a way. But to get this value, considerable space had to be sacrificed: No. 7 on the list, for example, has ten cars in the high-rise bank. In buildings on small plot areas, such as Nos. 9 and 10, there was not space enough to put in enough elevators for a first-class interval, and it will be noted that the interval for these buildings is longer than in the other buildings.

Such buildings illustrate another phase of the problem. The tower area is so small that the population is small, and a few elevators seem sufficient for the few people involved. Even if space were sacrificed for enough elevators to give a good interval, there would be a feeling that the expense was not justified. It is hard to make such buildings pay and give the highest service at the same time. Similar buildings erected in the future will probably be equipped with dual or double-deck elevators as a measure of economy as well as good service. We have seen elsewhere that Sixty Wall Tower, (No. 11 of the list) could not have secured a 29-sec. interval for the tower elevators without resorting to the double-deck type. One Wall St. (No. 5 on the list) is designed so that dual elevators can be installed in the future.

The floors above the floor of col. 7 are in some of the buildings (Nos. 2, 6, 8, 9, and 10) merely machinery levels, with perhaps a rented office here and there reached by the stairs. In buildings 5, 7, 11, and 12 there are several upper floors reached by shuttle cars that start at the level of col. 7. In buildings 1, 3 and 4 two or more cars of the high-rise bank run above the level of the others, as given in col. 7 for the occasional demands of the higher floors. Each such trip of one of more cars of the bank above the normal terminal upsets the schedule and impairs the service on the lower floors. Such arrangements for upper-floor tenants are not to be considered as satisfactory solutions of the elevator problem.

Average values—Although such figures have no real significance, because every building is a separate problem, it is interesting to take the average of the figures for these buildings. In doing so Nos. 7 and 12 are left out because their enormous plot areas make them quite different from other New York skyscrapers. From the other ten we find that the average New York skyscraper of 45 stories or more is 52.6 stories high (the highest level of good service, col. 7), stands on a plot area of 27,000 sq.ft. and provides 612,000 sq.ft. of net rental area. The average height is 750 ft., with great discrepancies in height of individual buildings with respect to actual story height, according to nature of the "peak" erected above to give the building temporary height supremacy, or for decorative reasons. If the Woolworth Building were added to these averages, it would increase them about 1½%.

The Woolworth Building was not included in the table because it was erected before the day of 1,000-ft. speeds and signal-operated elevators, and before the time when competition of other buildings focussed attention on the need for best elevator service. It is 792 ft. high, with 60 stories, on a plot of 29,670 sq.ft., provides 563,000 sq.ft. of net rental area and has a total of 29 elevators. Two elevators run to the 54th floor, and a shuttle car goes above this level to the observation tower. Two other cars run as high as the 47th floor, so it is the 47th that is the highest served by enough elevators to give a fair interval. The interval of departure from the ground floor for the cars serving the 48th to 54th floors is of the order of 1½ to 2 min., which of course is entirely outside any classification of good elevator service today.

The elevators are of 700-ft.-per-min. speed, are manually operated and represent the best available at the time of construction. However, the service rendered by the elevators in the upper part of the tower is inferior to that of many other buildings of lesser height erected at the same time. This merely emphasizes that the elevator problem, an acute one in buildings recently constructed, was still more acute twenty years ago. It is interesting to note that, except for buildings on very large plot areas, the economical story height of New York skyscrapers, as indicated by the ten recent ones, is about the same as the height of the Woolworth Building, erected in 1913.

Another illustration of the elevator problem is shown by the figures in

ELEVATOR DATA ON NEW YORK SKYSCRAPERS 45 OR MORE STORIES HIGH

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
							High-Rise Bank				Low-Rise Bank			
No.	Name	Plot Area, Sq. Feet	Total Height, Feet	Net Rental Area, Sq. Feet	Total Stories	Highest Floor With Full Elevator Service	Number of Cars	Floors Served Above the First	Number of Floors Served	Interval of Departure, Seconds	Number of Cars	Number of Floors Served	Interval of Departure, Seconds	Total Number Elevators in Building
1	Chanin	29,600	625	702,800	56	52[1]	6	30/52	23	29	5	10	20	24
2	Lincoln	42,000	733	850,000	55	53	9	29/53	25	21	6	10	16	29
3	40 Wall Street Bank of Manhattan	33,600	925	845,000	71	54[2]	6	38/54	17	29	8	12	13	44
4	Chrysler	37,000	1046	916,000	77	57[3]	6	44/57	14	28	8	12	13	32
5	One Wall Street. Irving Trust Co.	20,000	654	493,300	50	45[4]	6	26/45	20	27	8	15	15	29
6	500 5th Avenue	21,000	700	456,000	61	58	6	39/58	20	30	6	20	23	18
7	Empire State	83,800	1248	2,158,000	102	80[5]	10	68/80	13	21	4	7	24	67
8	City Bank-F'm's Trust	24,200	742	532,200	57	54	8	25/54	30	24	8	16	16	31
9	450 7th Avenue	15,000	525	316,700	48	45[6]	4	26/45	20	41	4	15	30	15
10	R. C. A. Lex. Ave.	16,300	643	324,900	50	48	5	23/48	26	34	6	22	24	11
11	Sixty Wall Tower	32,000	950	680,000	67	60[7]	8	29/60	16[9]	29	8	16	18	26
12	R.C.A., Radio City	99,800	850	2,500,000	69	66[8]	8	53/66	14	22	8	15	17	74

[1] Two cars go to the 54th.
[2] Four cars go to the 60th; shuttle car runs from 60th to 66th.
[3] Two cars go to the 67th; shuttle car runs from 67th to 71st.
[4] Shuttle car runs from 45th to 49th.
[5] Two shuttle cars run from 79th to 85th, and one from 85th to 102nd.
[6] One car of intermediate bank (five cars, serving the 16th to the 27th floors) is carried to the 45th, but is not regularly run with other four high-rise cars.
[7] One car goes to the 63d; shuttle car runs from 60th to 66th.
[8] Shuttle car runs from 66th to 69th.
[9] These are double-deck cars and make a maximum of 16 stops for 32 floors served.

col. 14 of the table, which give the average interval of departure from the ground floor of the elevators in the low-rise banks in the several buildings—the so-called local elevators. It is very easy to get in enough elevators to give not only good but superlative service to the tenants in the lower floors, because of short travel and the fact that space is not at a premium. The average interval is in most cases 30 to 50 per cent better than for the high-rise bank. The higher a tenant goes the poorer is his elevator service, usually to the accompaniment of higher rents also. In a few cases, as No. 7, the elevator service has been balanced.

Floor Space Per Car—At this point it might be appropriate to comment on the ratio of the number of elevators in a building to the net rental area. Some builders and owners have come to use a sort of rule-of-thumb ratio for preliminary calculations. Such formulas are anathema to the consulting engineer, who knows that every case is different. Taking extremes, it is clear that a very low building on an enormous plot might need no elevators at all, while a narrow tower with a small area would require a number determined by considerations of interval without regard to area and its consequent population.

In the case of the buildings listed in the table this ratio varies from 22,100 to 37,000 sq.ft. per elevator and averages 28,600. This is based on taking the total net rental area, including the ground floor, and the passenger elevators only, excluding service elevators, shuttle cars, private elevators, etc. If the quality of service in all these buildings were the same, there would be a reasonable uniformity in the values for buildings that are fairly similar in plot area and height.

Effect of car size

Increasing the care size improves the service to a certain extent, but there are definite limits. With larger cars, especially if they are wider than they are deep and have wide doors, people move in and out more quickly, and time is saved. But carrying more passengers per trip does not necessarily improve the service. The more people crowded in, the longer time is taken at each stop to load and unload, the longer are the cars held at the ground floor (usually, but not in the best-managed buildings) to wait for a full load, and the more stops will be made per trip by the law of probabilities. Hence the round-trip time is longer and the interval longer. Each case has to be calculated for the best car size. The selection of car sizes, like the other elements of an elevator installation, is a matter of the best compromise. The number of floors served, the probable population on each floor, the total rise, the nature of the inter-floor traffic, the nature and time of the peaks of traffic movement, the characteristics of the tenancy, the plan of the buildings, the location of columns—these and other factors enter into the determination of the number, size, speed, control and other details of the elevator plant.

The average practice in this country is to provide about 2 sq.ft. of cab platform area for each passenger, and a lifting capacity of about 75 lb. per sq.ft. For small cars the capacity per square foot can be less, but for large ones it must be greater, because a group of, say, twenty persons will fit themselves into an area less than twice that which ten persons will tend to occupy; that is, a big car will be relatively more heavily loaded.

Most of the buildings listed in the table provide elevators in the high-rise banks of 2,500 lb. or twelve-passenger capacity. A few provide cars of 3,000-lb. capacity. Buildings 7 and 12 of the list have cars of 3,500 lb. in the high-rise banks. The cars in the low-rise banks are generally larger, 3,000 lb. in most cases. The low-rise cars in No. 12 are 3,500-lb. capacity, in No. 7 of 4,000-lb. capacity, in No. 11 of 4,500-lb. capacity.

The question of elevator size is very different in a skyscraper from what it is in a department store or a museum or a subway station. Where large masses of people accumulate and travel is short, or more exactly where stops are few, cars much larger than those practicable in an office building may be used to advantage.

A succeeding article will describe the working of the dual and double-deck elevator systems and mention also certain other solutions of the problem of greater elevator capacity.

Bureau of the Census Reports on Construction

An analysis of the construction industry based on reports of 144,396 contractors who reported a 1929 business of $7,300,000,000

THE CENSUS of construction was undertaken for the first time in 1930. Separate reports are now being issued by the Bureau of the Census for each state. A preliminary report just published presents a brief summary of data available for the entire United States. A more complete report is now in process and will be available very shortly.

The statistics include not only data furnished by those usually known as contractors but also figures reported by manufacturers or fabricators of certain construction materials which they erect on construction jobs, as well as dealers and jobbers who operate a construction or installation department in connection with their sales business. Repair work and remodeling are considered on the same basis as new construction inasmuch as such work utilizes construction materials and employs construction labor. These statistics do not cover such part of the new construction and maintenance work of common carriers and federal, state and local governments as was done by their own forces.

Contractors to the number of 30,597 throughout the United States, who did a business of more than $25,000, and 113,799 contractors doing less than that amount reported a construction business during 1929 of about $7,286,000,000, including subcontract work let.

The reported business of the first group amounted to $6,250,266,665 (including $1,455,494,000 subcontract work let), and the estimated business of the second group was $1,035,453,579.

The value of "work done" by their own forces (total business handled minus subcontract work let, or the net value of construction work, excluding duplications by the 30,597 contractors) was $4,794,772,665, of which $2,055,595,482 (42.9 per cent) was paid out for construction materials delivered on the job, and $1,467,541,901 (30.6 per cent) for wages. The remainder, amounting to $1,271,635,282 (26.5 per cent), was accounted for by all other expenses, with a moderate allowance for profits. Assuming that the value of the business done by the smaller contractors was approximately the equivalent of the "work done" by their own forces (since they sublet little of their work), the estimated total net value of "work done," as distinct from gross business, was the sum of $4,794,772,665 plus $1,035,453,579, or a total of $5,830,226,244. If the expenditures of the smaller establishments were in the same proportion as those of the larger contractors, the amount they expended for materials was $444,209,585, and for wages $316,848,795, making a total expenditure by all contractors for these two items of $2,499,805,067 and $1,784,390,696, respectively.

Of the larger contractors, operative builders performed work with their own forces amounting to about $50,382,000, of which approximately $22,602,000 went for materials and $13,146,000 for wages. General contractors did work to the amount of about $2,926,489,000, some $1,188,687,000 going for materials and about $914,112,000 for wages. Correspondingly, the work of subcontractors in this group amounted to about $1,817,902,000, $844,306,000 being for materials and $540,284,000 for wages.

Underpass Carries Parkway Beneath Car-Track Street

Adjacent to and below the level of the Charles River Basin, the new grade separation of Memorial Drive and Massachusetts Ave. in Cambridge, Mass., forms a notable undertaking

By Joseph W. Parker
Consulting Engineer, Boston, Mass.

MEMORIAL DRIVE underpass in Cambridge, Mass., constitutes one of the most notable grade separations in the Boston metropolitan area. Adjacent to the Massachusetts Institute of Technology on one side and the Charles River Basin on the other, and located at the intersection of Massachusetts Ave., which carries heavy vehicular and street-railway traffic, and Memorial Drive, which carries heavy parkway traffic, the underpass solves a traffic problem that was steadily becoming more acute. Both in design and construction the underpass includes features of note. Traffic has been using the new facilities for some months.

Memorial Drive is built with two roadways and a grass plot 80 ft. wide between the roadways. The south roadway adjoins the Charles River Basin, with a wide sidewalk between the roadway and the basin. Massachusetts Ave. accommodates a roadway and sidewalk on each side of two electric-car tracks of the Boston Elevated Railway Co. The grass plot in Memorial Drive furnished an excellent opportunity to construct the inclines and approaches to the underpass within this area, providing for carrying the traffic on Memorial Drive under Massachusetts Ave.

Layout and design features

It was considered necessary to have an underpass of sufficient width to provide for two lines of vehicles traveling in each direction and also desirable to have a complete separation of traffic traveling in opposite directions through the underpass. Accordingly the layout was made for two roadways, each 21 ft. wide with a continuous island 3 ft. wide between and extending through the underpass and inclines, widening out at the approaches to the full width of the existing grass plot. A distance of 18 in. was fixed for the dimension from face of edgestone to face of wall of underpass. The inclines were placed on 4 per cent grades, with vertical curves at top and bottom having 50-ft. tangents As trucks and buses are excluded from Memorial Drive, it was possible to reduce the clear height of the underpass to a minimum of about 10 ft., which will be ample for all pleasure vehicles.

On account of the location of the structure it was decided that the surface of the walls, the coping and fence piers should be of granite. On the walls 4-in. sawed granite facing in slabs, some as large as 5½x11 ft., is used. The coping and fence piers are also sawed granite, except on certain faces where four-cut work was necessary to obtain pieces of exactly the same width. The main structure of the underpass is of reinforced concrete, with the exception of the roof of the covered section, which is constructed of 30- and 33-in. steel girders incased in concrete, with roadway and sidewalk slabs of reinforced concrete.

The entire structure, including inclines, is supported on concrete caissons, except the covered section, where the distance from the bottom of the invert to good bearing soil was so small as to make them impractical. In that portion of the work shallow continuous walls with L-shaped footings were constructed under the side walls, and shallow blocks of concrete about 15 ft. on centers were placed on the center line of the structure. There are three rows of concrete caissons, one row under each side wall and the third under the middle of the invert. A line of continuous concrete beams was constructed the entire length of the structure under the middle of the invert, and the bottom portions of the sidewalls, poured with the invert, were designed as continuous concrete beams. The invert was designed for a superimposed load of 100 lb. per sq.ft. over the entire area and also for an upward water pressure in the covered section and part way up the inclines.

The roof of the covered section was designed for 20-ton trucks with 50 per cent impact on the roadways and 50-ton cars with 25 per cent impact on the tracks.

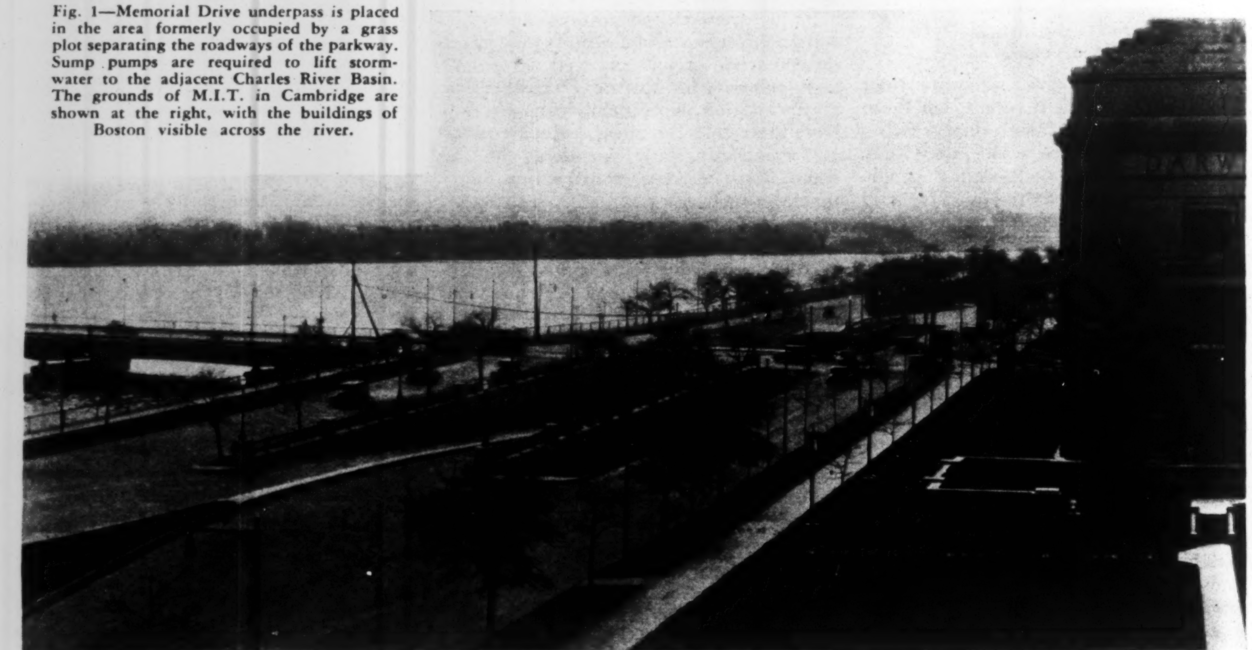


Fig. 1—Memorial Drive underpass is placed in the area formerly occupied by a grass plot separating the roadways of the parkway. Sump pumps are required to lift stormwater to the adjacent Charles River Basin. The grounds of M.I.T. in Cambridge are shown at the right, with the buildings of Boston visible across the river.

as required by the Massachusetts department of public utilities for highway bridges carrying railways. Granite edgestones are used throughout, and granite block paving with cement grouted joints was laid both on the underpass roadways and the Massachusetts Ave. roadways over the covered section. Three-ply asphalt membrane waterproofing is used on all inverts, side walls and the roof of the covered section. An improved Boston pattern fence of heavier and more permanent construction than the usual type is used between massive granite piers spaced about 45 ft. on centers. It was considered desirable to reinforce the top rail of the fence to prevent any vehicles from crashing through to the roadways of the underpass, and accordingly a ¾-in. steel-wire rope has been placed within the 3-in. steel pipe, which forms the top rail of the fence. Turnbuckles were placed at intervals to permit tightening the rope when placed and also to provide for removing only a short section of the rope and fence in case of accident. A number of studies and comparative estimates of cost were made to determine whether the covered section under Massachusetts Ave. should be designed with or without a center wall or row of columns on the center line of the underpass. It was finally decided that the structure should be designed without either, as the appearance of the completed structure would be much better and the difference in cost small.

Drainage and pumping

As the low points of the underpass roadways are 4 to 5 ft. below the level in the adjacent Charles River, catchbasins had to be built to collect the stormwater, and means had to be provided for removing it. Accordingly a sump pit with a pump chamber over it was constructed adjacent to the south wall of the underpass. Two catchbasins of adequate size were constructed under the invert at the low points—one under each roadway—and these catchbasins were connected with each other and with the sump pit by 8-in. pipes. Two vertical centrifugal pumps with direct-connected electric motors were installed in the pump room. Each pump has a capacity of 600 gal. per minute under a head of 20 ft. and is equipped with floats and rod for automatically starting and stopping the motor when the water in the sump pit reaches certain levels. The pumps are of sufficient capacity so that either can handle the entire drainage during a period of maximum rainfall. The pumps discharge through 4-in. cast-iron pipes into a large manhole adjacent to the pump room, from which the water flows by gravity through a pipe to the Charles River Basin. The motors that operate the pumps are connected to independent sources of power supply, one being 550-volt alternating current and the other 600-volt direct current. By this arrangement the power supply is assured at all times.

In order to drain as much of the inclines as possible without recourse to pumping, two catchbasins discharging directly into the Charles River Basin were constructed under each incline a portion of the way down.

Construction

It was apparent from the beginning of the work on the drawings that special consideration must be given to the method of construction of the covered section at Massachusetts Ave. The problem at that point was complicated by the fact that traffic on Massachusetts Ave., both vehicular and street railway, had to be maintained at all times during the construction operations. Several possible methods were carefully considered. After considerable study of the various methods the conclusion was reached that the quickest and most economical method was to construct first the west portion of the covered section, including the supporting beams for both car tracks, by the open-cut method without temporary bridging. Temporary car tracks were laid on the east side of Massachussetts Ave. a sufficient distance from the existing tracks to permit excavation for the west portion, and a temporary roadway for vehicles was constructed across the grass plot east of the temporary car tracks. In order properly to support the soil adjacent to the temporary car tracks during the excavation for the west portion, steel sheetpiling was driven and later removed during the excavation for the east section. The proximity of Harvard Bridge to the site made necessary the temporary strengthening of the sidewalk construction of the bridge during this shifting over of traffic. After the construction of the west section of the roadway, the car tracks were laid in their permanent position on the roof of the structure. Granite block pavement was laid on the west roadway, and traffic was permitted to use the completed section. The east half of the covered section was then constructed.

The construction of the inclines began prior to the construction of the west half of the covered section and proceeded along with that construction. No sheeting was necessary along Memorial Drive except at sections adjacent to and through Massachusetts Ave. where steel sheet piling was used. Considerable pumping was necessary during the construction, but there was not as much difficulty from seepage as had been anticipated. A particularly interesting feature of the construction work was the use of the granite facing as forms for the inside faces of the reinforced-concrete walls of the underpass. The facing was successfully held in a vertical position and on line during the pouring of the concrete, and the completed work showed the results of careful work in this operation.

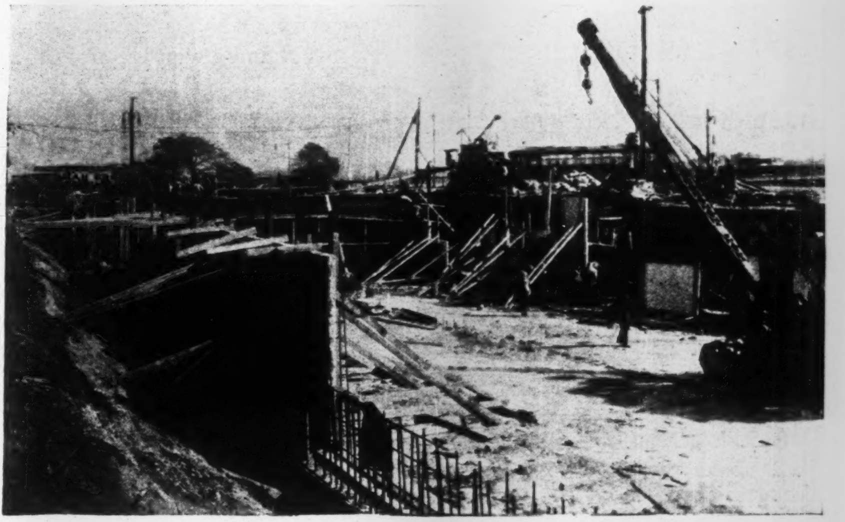


Fig. 2—In constructing the Memorial Drive underpass, granite facing slabs were used as inside forms for the retaining walls. The bridge over the underpass utilizing rolled girder beams was built half at a time to maintain traffic on Massachusetts Ave.

Organization

The Memorial Drive underpass was a project of the Metropolitan District Commission, of which Davis B. Keniston is chairman. It was authorized in the act of the state legislature providing for extensive improvements of the Charles River Basin. The layout and design of the structure and its approaches were made under the general direction of the late Edwin H. Rogers, director of park engineering, with the writer as consulting engineer. The general contractors were Coleman Bros., Inc., Boston, Mass., with Steven R. Berke as general superintendent on the job.

Book Reviews and Notes

A Monthly Commentary on Current Additions to the Civil Engineer's Library

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Public Utility Problems

PRINCIPLES OF PUBLIC UTILITIES—By Eliot Jones, Professor of Economics in Stanford University, and Truman C. Bigham, Professor of Economics in the University of Florida. Cloth; 6x9 in.; pp. 799. Published by the Macmillan Co., New York. $6.

The pros and cons of economics of public utilities are discussed fully and dispassionately in this book. The services covered are electric light, power, gas, street railways, telephone and water. Railroad problems are not discussed because their different problems required separate treatment. Further, Prof. Jones has covered the subject in his book "Principles of Railway Transportation." The present work is designed primarily to meet the needs of teachers and students for a concise presentation of the facts bearing upon many of the controversial matter in public utility relations and regulations. Because of its form, that of presenting the arguments for an against all major issues, and because it is well written, many others interested in utility problems will find the book useful.

* * *

Brought Up To Date

PRINCIPLES OF REINFORCED CONCRETE CONSTRUCTION—By F. E. Turneaure and E. R. Mauer, dean of the College of Engineering and professor of mechanics, respectively, University of Wisconsin. Fourth edition. Cloth 6x9 in.; pp. 461; numerous charts and line drawings. Published by John Wylie & Sons, New York and London. $4.

The past decade has witnessed substantial advance in our knowledge of reinforced concrete and recorded some important changes in several theories. Inasmuch as the last previous edition of this well-known text was published in 1919, the need for a revised edition was imperative. Noteworthy in the new edition is the importance assigned to the effects of shrinkage and plastic flow in beam, column and arch designs. New column data are presented, although the recent Lehigh and Illinois tests are rather incompletely analyzed. These tests are treated as just another investigation whereas they represent the most comprehensive column study ever undertaken and may become the most significant. For example, no mention is made of the fact that these tests indicated that the term n, so much a part of all concrete formulas, may change so rapidly as to have no meaning. If this indication should be accepted as fact a very great change in concrete design practice would result. The authors choose not to advise the readers of this or to consider its implications.

In all other respects the book reflects modern design thinking and practice. The material given on flat slabs has been amplified and a detailed treatment of footings has been added. More adequate development of the analysis of continuous beams is included. In the chapter on building frames, application of the slope deflection method is considered in some detail. Also, in this chapter the Cross method of moment distribution is explained in its application to continuous girders and frames. A complete detailed analysis of the reinforced concrete arch with methods of arriving at tentative designs form the subject matter of a new chapter. In the appendix, formulas and diagrams have been revised in accordance with recent knowledge.

* * *

Fundamentals of Stresses

STRESSES IN SIMPLE STRUCTURES—By L. C. Urquhart and C. E. O'Rourke, professor and assistant professor of structural engineering, respectively, Cornell University. Second edition. Cloth, 6x9 in.; pp. 333; numerous diagrams. Published by McGraw-Hill Book Co., New York and London. $3.50.

In revising this book, first published in 1926, the authors have added two new chapters and altered the arrangement of some of the material, notably in grouping all information on influence lines in one chapter. The two new chapters are on the three-hinged arch and on deflection calculations. In the latter chapter such methods as the use of the differential equation of the elastic curve, the moment-area method and the principle of work are explained. The new addition retains the basic characteristics of the first edition, namely, that of text book devoted to the fundamentals of stress calculation in roof trusses, framed bents, bridge trusses, beams and girders, without reference to or consideration of design economics.

* * *

A New Truss

THE WICHERT TRUSS—By D. B. Steinman. Cloth; 6x9 in.; pp. 138; numerous line drawings. Published by D. Van Nostrand Co., Inc., New York City. $2.75.

Briefly, the Wichert truss is a statically determinate continuous truss or a plate girder, its peculiar characteristic being the arrangement of the members or supports over the intermediate piers in the form of a quadrilateral with pin or rocker joints. Developed by E. M. Wichert, of Pittsburgh, this new type of truss is held to offer many advantages. In developing the theory of the truss, which is the subject to which the book is devoted, the author brings out these advantages very clearly. Economies in material, foundations cost and erection time are claimed for the Wichert truss. Unusual rigidity under traffic is an inherent characteristic. Ease and accuracy of analysis are features, and stresses are unaffected by temperature differences between the chords and negligibly affected by pier settlement. It thus may be used where cantilevers are ordinarily required. It may also be adapted to arch or suspension bridge outlines by virtue of the fact that moment distribution is under easy and certain control. The author concludes that the advantages of the Wichert truss recommend its use "under almost all conditions."

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Municipal Light Plants

THE MANAGEMENT OF SMALL MUNICIPAL LIGHTING PLANTS—By Frederick L. Bird. Cloth and paper; 6½x10 in.; pp. 141. Published by Municipal Administration Service, 309 East 34th St., New York, N. Y., paper $1, cloth $1.50.

This monograph by Mr. Bird the author of "Public Ownership on Trial" is based on his wide study of municipal utilities throughout the country, but the supporting data are confined to New York State. The book covers administrative organization and management, financial policies, rates and rate structures, record-keeping and accounts, revenue and costs, operating data, state regulation of municipal light plants and conditions of successful management. The latter chapter includes a statement of prerequisites of successful management and legal limitations to successful municipal ownership.

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Power Dramatized

Reviewed by J. M. Weed

Assistant Director, Engineering Experiment Station, Ohio State University, Columbus, Ohio

BEHEMOTH, THE STORY OF POWER—By Eric Hodgins and F. Alexander Magoun. 6x9 in., pp. 354, illustrated. Published by Doubleday, Doran & Co., Garden City, N. Y. $3.50.

HERE is part of the long-awaited history of engineering. Smartness and high good humor make Behemoth as delightful as the latest sophisticated biography. It traces the story of power from that earliest engine, the human body, through the use of the muscles of horses and oxen to the most recent developments in the emancipation of the race from physical toil. Though the specialist may raise the cry of superficiality, the information in this book undoubtedly pleases and satisfies the general reader, including in that classification most technical men. On p. 2 is a footnote defining horsepower and expressing the hope that this will be the only footnote in the book. It is.

The treadmill locomotive for the South Carolina Ry, is described as having benches for passengers on the platform alongside the horse and subject to "any indignities that it might think of." Dr. Roebuck, whose acquaintance James

Watt was fortunate in making, was engaged in the "melancholy pursuit" of operating coal mines. Sir Humphrey Davy turned down Michael Faraday, but when the great man of science was blinded in a laboratory experiment he bethought himself of Michael's careful penmanship and gave the young man his chance after all—by implication a plea for good penmanship. And though the power engineers are not defended from the charge of letting go to the dogs a world whose economists and sociologists have failed to keep up with developments, they are at least, say the authors, not crass materialists, for "of the two great media of power, steam and electricity, one is imponderable and both are invisible."

The authors of such a corking book deserve attention. Magoun is professor of Humanics at Massachusetts Institute of Technology, and Hodgins was on the English staff of the same institution.

An Outstanding Report on Regional Planning

REGIONAL PLAN OF THE PHILADELPHIA TRI-STATE DISTRICT—Findings and Proposals: Cloth; 8x11 in.; pp. 589; numerous tables, diagrams, halftones and maps. Published by the Regional Planning Federation of Philadelphia Tri-State District, 1420 Walnut St., Philadelphia, Pa. Report and map $10 less a 25 per cent discount to professional men interested in planning.

SETTING a new standard of intercommunity cooperation, the Philadelphia Tri-State District has recently put out a report for a comprehensively planned region. As the officials originally intended, the work is a practical and constructive contribution to the progress of the region rather than a purely visionary and idealistic treatise.

The report consists of two sections. The first covers policies, procedure and findings, existing development, population, transportation, highways, port and rail facilities, airways and airports, parks and parkways, water supply and sanitation and architectural and esthetic elements of planning. The remaining section, an appendix, contains detailed supporting technical data and other planning information. Some of the recommendations follow: After reviewing all of the various water-supply studies made for Philadelphia, the federation recommends that all the proposed sources be acquired and protected as potential future resources. Further it is stated that an immediate program of progress in construction, beginning with near-by sources and advancing to the utilization of more distant sources, in the tributaries of the upper Delaware and Lehigh rivers, could and should be developed to permit of economic utilization of both old and new works during an extended period of construction.

By 1980, the design end point of the report, 22,500 miles of highways and streets will be needed. A 2,500-mile backbone of this system is laid out, 800 miles on new right-of-way. Five additional airways are suggested to serve the region, also one transport terminal, 25 aerial service bases and seven auxiliary landing fields.

In addition to the usual recommendation of 10 acres of parks per 1,000 persons, 800 miles of parkways are suggested in stream valleys.

Most elaborately illustrated, well indexed and excellently summed up for the busy business executive, this report should make the task of putting its proposal into effect comparatively easy. As intended, it is practical and will be of material value in shaping the course of future development of this immense industrial and commercial region.

Miscellaneous Notes on Booklets and Reprints

MANY FACTS ABOUT RAILROADS are given in the current Yearbook of Railroad Information published by the Committee on Public Relations of the Eastern Railroads, 143 Liberty St., New York, N. Y.

AN INSPIRING SKETCH OF JEAN JADOT, the great Belgian engineer and empire builder who died early this year, is given by Herbert M. Prové in a reprint, in extenso, of a memorial printed in the *New York Times*, May 8, 1932. Copies may be obtained from H. M. Prové, 120 E. 39th St., New York, N. Y.

CURING CONCRETE with silicate of soda is the subject of a pamphlet by the Sodium Silicate Institute (121 S. Third St., Philadelphia, Pa.). Application of sodium silicate curing to concrete highways is described in detail together with specific examples of practice in some states. Copies will be sent free to highway engineers. To others the price is $1.50.

MORE THAN 47,700,000 PEOPLE were living in 1,150 zoned cities, towns, villages, boroughs and incorporated areas of towns on Jan. 1, 1932, according to reports issued by the division of building and housing of the Bureau of Standards. These show that city planning commissions have been established in 828 cities and towns and that there are 79 regional planning commissions in the country. The report, "A Survey of Zoning Laws and Ordinances Adopted During 1931," shows that at the end of that year 83 of the 93 cities of the United States with more than 100,000 population have zoning ordinances in effect, and also that 277, or a majority, of the cities of over 25,000 are zoned. "A Survey of City Planning and Related Laws in 1931" shows that 87 laws were enacted, in 27 different states, having reference to such matters as city and regional planning, state planning, highway development, parks, parkways and recreation areas, airports and condemnation of land for public uses. In "A Tabulation of City Planning Commissions in the United States" the 828 planning commissions now established in cities, towns and villages are shown to be well distributed throughout the country, Massachusetts leading with 121, followed by New York with 114, California with 108, Ohio with 79, Pennsylvania 56, and Illinois 51. The bureau's latest report on Regional Planning Commissions lists 79 such commissions, 55 of which are regional planning commissions created as the result of legislation, and the other 24 are organizations voluntarily formed through the interest of public-spirited individuals and organizations. Of the 55 official commissions 45 are county planning commissions and four are state organizations. Copies of any of the four pamphlets are available from the division of building and housing, Bureau of Standards, Washington, D. C.

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

REINFORCED CONCRETE DESIGNERS' HANDBOOK—By Chas. E. Reynolds. Cloth; 7x10 in.; pp. 297; many tables and line drawings. Published by Concrete Publications, Ltd., London, England. 15s.

A NEW DEAL—By Stuart Chase. Cloth; 6x8 in.; pp. 257. Published by the Macmillan Co., New York City. $2.

POPULATION CHARACTERISTICS BY CENSUS TRACTS, CLEVELAND, OHIO, 1930—By Howard Whipple Green. Cloth; 9x12 in.; pp. 236; numerous tables, maps and line drawings. Published by The Plain Dealer Publishing Co., Cleveland, Ohio. $25.

DESTRUCTION OF TIMBER BY MARINE ORGANISMS IN THE PORT OF SYDNEY—By Tom Iredale, R. A. Johnson and F. A. McNeill. Paper; 7x10 in.; pp. 148; numerous diagrams and photographic illustrations. Published by The Sydney Harbour Trust, Sydney, Australia.

SEWERAGE AND SEWAGE TREATMENT—By Harold E. Babbitt, professor of sanitary engineering, University of Illinois. Fourth edition. Cloth; 6x9 in.; pp. 596; numerous illustrations. Published by John Wiley & Sons, Inc., New York and London. $5.

UBER DEN SICHERHEITSGRAD VON HOCHBEANSPRUCHTEN EISENBETONKONSTRUKTIONEN—By H. Olsen. Paper; 7x10 in.; pp. 144. Published by Wilhelm Ernst & Sohn, Berlin, 15 marks.

THE PORT OF HAMBURG—By L. Wendemuth and W. Bottcher. Second edition. Cloth; 7x9 in.; pp. 278; many illustrations. Published by Meissner & Christiansen, Hamburg, Germany.

THE PORT OF WILMINGTON, DEL., and PORTS ON THE DELAWARE RIVER BELOW PHILADELPHIA. Port Series No. 4, Part 2; revised 1931. —Prepared by The Board of Engineers for Rivers and Harbors, War Department in cooperation with the Bureau of Operations, United States Shipping Board. Paper; 6x9 in.; pp. 119; maps, tables and photographic illustrations. Published by the Superintendent of Documents, Washington, D. C. 25c.

Engineering News-Record

EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, W. G. Bowman, F. W. Herring, C. S. Hill, H. W. Richardson, W. W. De Berard, N. A. Bowers, J. I. Ballard.

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A Word About Cooperation

THREE MONTHS hence most communities throughout the land will be struggling again with an unemployment problem and casting about for productive work that will reduce the length of their breadlines. Financial assistance for such work is now available from the Reconstruction Finance Corporation in the form of loans on self-liquidating projects. But it is the task of the communities themselves to plan the work, apply for the loans and put the men to work. Much remains to be done, and every community has its share. Projects must be studied, plans drawn, cost and revenue determined; many steps of financial and administrative authorization are necessary. Only on the basis of such thorough preparation and cooperation on the part of each local community can the R.F.C. release the funds entrusted to it. This is no time for public or official apathy, or for preoccupation with politics. It is the time for hearty and effective cooperation. Money lies idle in Washington; men remain idle in every community; both should be put to work. The responsibility rests with the local authorities.

Encouraging Signs

WITHDRAWAL of R.F.C. loan applications by the Golden Gate Bridge in Highway District and by the city of Pasadena because both have been able to make advantageous sales of their bonds to local bankers is a most encouraging sign of improvement in financial conditions. Six months ago the financing of new construction was at a standstill, not because of an unwillingness on the part of many communities to go ahead with new work but because bankers refused to take their securities at reasonable rates. This latter fact was one of the impelling forces back of the drive to get provisions for financing of self-liquidating projects into the Relief Act. But it was foreseen even then that government support of municipal finance would operate powerfully to rehabilitate the open market for municipal securities. The recent happenings reported show that this expectation is being fulfilled. It is a hopeful outlook, giving promise of a valuable supplement to R.F.C. operations.

Auspicious Beginning

QUIETLY and smoothly New York's municipally operated subway system began operation this week. Dummy trains had been running for some days, and at the appointed minute they began receiving and handling crowds of passengers as if that were old routine. The organizing and preparatory work was done by a construction engineer, Col. J. R. Slattery, to whom high recognition is due for the auspicious start of the system. Present prospects are that the novel experiment of municipal operation will register an entire success. But larger questions remain to be disposed of, for three separate systems are now operating. Whether competition between lines or integration of the whole rapid-transit network into one operating entity is preferable has yet to be settled. The regrettable present fact is that operating contracts framed with the help of the best financial and legal skill have not been effective in producing a stable, satisfactory or solvent operating condition, and cooperation of city ownership with private operation has to this extent failed to justify itself. The experience in operating the municipal line will doubtless help in pointing toward the ultimate solution—a result much to be hoped for, in view of the continued pressure of rapid-transit needs in every metropolis.

Logic in Planning

IMPROVEMENT of highways in the metropolitan district of Cleveland is proceeding in remarkably logical order, from diagnosis to determination of treatment and then to application of remedies. The procedure deserves consideration, particularly in respect to the intermediate operation of determining the treatment. Too often its necessity is not appreciated. The diagnosis of traffic demands by vehicle counts and classifications—as through the traffic survey that was made in Cleveland three years ago—outlines the needed facilities for improved traffic movement by zones rather than by definite road locations. Within any one zone various possible locations will meet the traffic need. But the choice between possible locations often presents a nice problem of relative engineering economics, whose solution must precede the ultimate operations of design and construction. In the regional road development of metropolitan Cleveland this intermediate operation is made a separate function of a specially organized bureau. The procedure and some of the problems of this bureau, as described in the present issue, indicate clearly its useful purpose—a purpose, incidentally, that is being accomplished by reallocation of existing engineering personnel, in large measure without payroll addition.

Improving the Skyscraper

PROGRESS as embodied in the production of new equipment sometimes offers improvements which the consumer for one reason or another is not ready to accept. Such a situation apparently exists in connection with elevators for tall buildings. Two elevators in one shaft, either separate cars or double-deck single cars, are economically superior to a one-car installation. But until quite recently the safety as well as the working efficiency of the two-car system was in question. The two-car system has now been perfected mechanically; yet, despite its economic superiority building owners still hesitate to adopt it, not only through natural reluctance to pioneer but also for fear that tenants might disapprove of something requiring even slight change in their habits. This attitude may have been justified in the past but today it must face the realities of comparative economics. A building's efficiency is becoming more and more a matter of the efficiency of its elevator installation, and as increased speed no longer offers much advantage the only solution seems to be more cars. The comparative economics of various elevator systems are presented in two articles beginning in this issue, written by an engineer long identified with elevator development. Considering that the elevator made the tall building practicable, the articles indicate that, as used in the past, it has not made the skyscraper as profitable or as efficient as it should have been or as it must be in the future.

Old Teachings

A QUARTER-CENTURY ago the world was under the shock of a great disaster. Word had come on Aug. 29, 1907, that the partly erected Quebec cantilever, a bridge that was to surpass the renowned Forth Bridge, had collapsed, carrying nearly 100 workers to their death in the deep waters of the St. Lawrence. For a time engineering skill was under a cloud of doubt and distrust. Fuller knowledge of the facts soon dispelled the doubts, but it also taught the engineering profession one of its most memorable lessons.

Until the moment of the collapse there had been unquestioned faith in the adequacy of the work. Its safety was thought to be assured by every resource of skill and ability. Supervised by the most respected bridge engineer of his day and built by an old-established construction organization, the structure seemed to embody all that modern engineering skill could offer.

It was not long before the true state of affairs was revealed, however. Within a few days this journal reported the major facts, describing the physical happenings of the failure and telling of prior evidences of weakness. Later the full story was traced out in detail by a commission of inquiry whose work will live in engineering history as a model of thoroughness. Under the leadership of the able and fearless Henry Holgate, of Montreal, the investigation delved into all corners of the history and technical management of the work. It brought to light a tragic record of organizational laxity and engineering faults. In these lie teachings that deserve to be remembered even today.

In respect to organization and management, conditions were revealed that were not new in human affairs and had led to disappointment and failure time and again. The fundamental principles of sound management and competent direction of work had been ignored in favor of considerations of profit. A speculative enterprise of marginal character, in fact one made feasible only by governmental subsidy, the bridge project had been managed in utter disregard of the dictates of prudence. Thus, unintended and unsuspected weakness in the structure came into being.

That the individuality of the task at Quebec was misunderstood proved to be fateful error. When the designers chose the outlines of the bridge they did what was known to be adequate in ordinary size, overlooking the increased influence of distortion on their large-scale construction problem. Again, when they proportioned the massive compression chords they followed the habits established by small-size experience, in which a pair of ribs braced together by conventional latticing had been found to produce a fairly sturdy column. Their huge compression chords, with ribs made of a number of thin, wide plates stitched together and braced by latticing too weak to hold the ribs in position, were fairly beyond the limits of ordinary experience. Even in the fabricating shop the weakness of the flimsily integrated members might have been detected, but faith in current practice was strong enough to silence question. But when the bridge was being erected, their inherent weakness, accentuated by the violent straining of the sharply bent chord polygons as the anchor arm was lifted off its falsework by the weight of the cantilever, resulted first in alarming distortions of the members at their abutting joints and then in abrupt crumpling failure in the most heavily stressed panel.

Engineering faults thus were directly responsible for the collapse. They resulted from the engineers' inability to see the work in its true magnitude; and back of this lay faulty organization and divided responsibility.

The story of the weak compression chords goes beyond this, however. In 1907 the strength of columns was less fully known than the strength of other elements of construction. In some degree this is true even today, as it has been since Euler's day; but the studies which followed the Quebec disaster brought much greater knowledge and sureness into the field. The importance of shear, the profound effect of conditions at the ends, and the dominant importance of solid, integral assembly of the components of a built column, have come to recognition chiefly since that great failure.

Subsequently the Quebec Bridge was rebuilt. For 15 years it has been carrying trains across the St. Lawrence channel, proof that the enterprise attempted in 1907 was not beyond the range of engineering skill. But its difficulty is reflected in the absorbingly interesting history of the undertaking during the ten years after 1907, a history that included another accident, one due to the failure of an item of erection equipment and not important to the present purpose. The essential difference between the successful structure and the one first attempted was not so much greater knowledge as better organization, effective joining of competence with directing authority, and thorough appreciation throughout of the responsibilities involved in the work.

Much progress has been made in bridge engineering during the quarter century—in abler design, in better materials, in excellence of workmanship, and in ability to overcome erection difficulties. The gigantic bridges and building frames of the past decade are visible expressions of this progress. Columns in particular have attained a high level of constructive skill; solid-section design is applied to members even of great size, aided both by a wider range of rolled sections and by elaborate tests of the strength of columns and their elements.

At the same time the magnitude of the problems placed before the structural art has grown correspondingly, and achievement as often approaches the limits of skill and knowledge as it did when the Quebec bridge was first attempted. In recognition of this it has become customary to conduct special investigations when major projects are carried out, in order to give due certainty on doubtful points or to provide test data for safe design. The custom of making such studies as well as a generally increased sense of technical responsibility, with resulting better grasp of new problems—especially in public projects—gives better assurance against a failure like that of Quebec than we had a quarter century ago. This assurance may be placed on even more solid foundation if engineers will turn back now and then to the St. Lawrence River tragedy and consider its warnings. They have enduring significance for sound engineering achievement.

NEWS OF THE WEEK

Loan for Dotsero Cut-off Passed by Ry. Commission

A loan of $3,850,000 by the Reconstruction Finance Corporation to the Denver & Rio Grande Western Ry. Co. was approved by the Interstate Commerce Commission on Sept. 12. The loan is to be made to the company to permit it to construct the Dotsero cut-off connecting the Denver & Salt Lake R.R. west of Moffat Tunnel with the main line of the Denver & Rio Grande Western at a point almost directly west of Denver where the two railroads are 42 miles apart.

Construction of the cut-off will shorten the route from Denver to Salt Lake City by the D.&R.G.W. by about 135 miles, or to 610 miles. As originally projected the Denver & Salt Lake Ry. would have cut the distance to 556 miles, as compared with 620 by the Union Pacific and 745 by the D.&R.G.W. Ry.

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Greeley Gets Money for Pipe Line at Low Rate of Interest

So strong is the financial credit of Greeley, Colo., that a bond issue of $225,000 for water works improvements was sold Aug. 30 to Denver investment brokers at 98¼. The coupons bear 4 per cent. Consultation with the Reconstruction Finance Corporation indicated that it was inadvisable to go through with formal application with any idea of getting money at a lower rate.

The proceeds of the bonds are to be used to replace with cast iron pipe, 11.1 miles of 20-in. wood stave pipe line bringing water from the mountains to the city. Immediately after the bonds were sold bids for the pipe were opened and contract awarded to the low bidder, the Colorado Fuel & Iron Co., Pueblo, Colo., for $147,000. The bid was so low city officials were able to cut the bond issue to $200,000.

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Forest Road Funds Allotted by Agricultural Department

Apportionment of the $5,000,000 provided for the construction of forest roads under the Emergency Relief and Construction Act was approved by the Secretary of Agriculture on Sept. 10. The money is to be spent on road construction within the forest preserve in 34 states and territories. The National Forest highway fund is allocated, half according to the national forest area within each state, and half according to the ratio that the value of the forest land in the state bears to the total value of the national forest land in all the states.

The principal items are as follows: Arizona, $347,800; California, $829,600; Colorado, $397,500; Idaho, $614,300; Montana, $480,400; Nevada, $111,100; New Mexico, $244,500; Oregon, $753,100; Utah, $198,600; Washington, $426,500; and Wyoming, $263,600.

First R.F.C. Loan for Construction Goes to Los Angeles

A LOAN of $40,000,000 for the start of work on the Los Angeles aqueduct was approved by the directors of the Reconstruction Finance Corporation on Sept. 13. This is the first loan to be made for a self-liquidating project under the Emergency Relief and Construction Act. The aqueduct is being built by the Metropolitan Water District of Southern California to bring water from the Colorado River below Hoover Dam across California to serve a group of 13 cities in the Los Angeles region. It will be 240 miles long and will cost $220,000,000 (*ENR*. June 16, 1932, p. 847).

Representatives of the Port of New York Authority, on Sept. 13, discussed with the directors of the R.F.C. the possibility of a loan for the start of the 38th St. vehicle tunnel under the Hudson River at New York. On Sept. 24 the board will consider an application for a rapid-transit tunnel under the Narrows at New York to connect Staten Island with the new Independent Subway System in Brooklyn.

Vehicle tunnel considered

Pasadena, Calif., has withdrawn its request for a loan of $5,000,000 to $6,000,000 from the Reconstruction Finance Corporation because it has been able in recent weeks to sell its securities to private bankers under attractive conditions. The money is to be used for extensions and improvements of its waterworks system. Financing of $225,000 worth of waterworks construction at Greeley, Colo., is now also being handled through private investment houses, as noted in an adjoining column.

Milwaukee filter plant

J. P. Schwada, city engineer, and H. T. Bohmann, superintendent of water, Milwaukee, Wis., are preparing project plans for a filtration plant for the city to be financed in part by a loan from the R.F.C. Milwaukee credit is excellent but recently a reduction was effected in tax valuation, bringing its total of existing bonds outstanding near the bond limit. For this reason the collateral to be offered will probably consist of mortgage certificates now held feasible under the Nye law or if not, to be made so by the state legislature in November. The certificates to be issued will be secured by water plant and filtration revenue, rather than general taxation. From $1,500,000 to $2,000,000 is the sum likely to be asked for although the total plant will cost upward of $4,000,000. Milwaukee recently reduced its water schedule from 7 cents per 100 cu.ft. to 6 cents, equivalent to an annual reduction of $350,000, but even with this reduction the filtration plant can be paid for within a ten year period, Mr. Bohmann states.

Railway work planned

Aid of the R.F.C. is being sought for erection in Paducah, Ky., of a $65,000 river-rail terminal. A proposal for constructing the terminal was launched more than a year ago with a view to facilitating freight movement from river to rail and from rail to river transport. It is planned to reconstruct a large warehouse and to install cranes and other loading equipment. Railroad facilities are already available at that point.

The city of Fort Worth, Texas, will apply to the R.F.C. for a loan of $600,000 with which to finance work on overpasses at railroad crossings, city manager Fairtrace has indicated.

Bellwood, Ill., has made application for $180,000 with which to purchase the existing well supply at $80,000 and to extend the plant with a pumping station, a new well and an elevated storage tank. Water revenue bonds are offered as collateral. Edwin Hancock is engineer for the municipality.

Denver, Colo., has made informal application for $1,500,000 for waterworks improvements to supplement a plan already under way for reducing the cost of pumping water into the Capitol Hill district. Several miles of 66-in. pipe line and a 50,000,000 gallon storage reservoir are the essential features. With the program completed a low rate for electricity can be earned and an estimated saving of $90,000 per year made. C. B. Gross is engineer.

Chicago seeks large sum

The board of trustees of the Sanitary District of Chicago voted Sept. 8 to ask for $36,450,000 with which to continue work on the Calumet, West Side and North Side sewage disposal projects and interceptors leading to them. Of this amount $8,793,000 is for contracts already let but held up because of inability to sell bonds authorized and issued. The district contends that it is in part self-liquidating in that it has annually $1,000,000 revenue from the sale of electricity, $250,000 from sale and rental of land, and $40,000 from the sale of stone. The attorney will make the further claim that taxes already levied must be especially set aside for the purpose of sewage treatment only, hence these bonds are self-liquidating. The above amount requested will finance the district up to Jan. 1, 1934. Work can begin within a few days on contracts already let and shortly 4,000 men can be employed.

An application for federal credit for the construction of a river terminal to cost about $200,000 is under consideration at Greenville, Miss.

A reinforced concrete and steel bridge across the Missouri River at Farnam St., Omaha, Neb., has been proposed to the R.F.C. as subject for a loan of $1,500,000. Robinson & Steinman, New York, are the engineers on the bridge.

Port development

Port development of Detroit, Mich., is under consideration and it has been suggested that a loan of $7,000,000 from the R.F.C. be requested for that purpose. Fees collected for the use of the port facilities would be used to pay the principal and interest on the loan. It is planned to construct the facilities so as to accommodate ocean vessels.

The voters of Gulfport, Miss., have approved the issuing of $150,000 bonds for the purpose of erecting a compress and warehouses at Gulfport. It is planned to seek the aid of the R.F.C. for financing the bond issues. Plans are being rushed so that construction can begin as soon as possible.

A $2,000,000 bond issue to finance necessary water department extensions and improvements, has been agreed upon by the city council of Seattle, Wash. A resolution has also been adopted by the city council authorizing and directing the mayor to make application to the R.F.C. for a loan of $1,861,000 for water department extensions and betterments.

The $2,000,000 bond issue will provide funds for pipelines in the Cedar River watershed. Among the largest jobs planned are: Construction of a 50,000,000 gallon concrete lined reservoir near the present Maple Leaf reservoir; replacement of pipelines between Lake Youngs and the Landsburg intake on the Cedar River watershed; replacement of the wooden crib dam across Cedar River at Landsburg by a concrete structure; constructing 7,500 ft. of 24 in. main, in the Denny Way-Bell Street district; draining and irrigating slopes of West Seattle reservoir; excavation and removal of soil from the flooded area of the Lake Youngs storage basin; construction of a quantity of water mains throughout the city.

Jobs will be rotated on the work, giving as much work as possible to the 12,000 registered applicants, on a basis of three five-day weeks, on a six-hour day basis.

Public Building Work

Any doubt that the condition of the federal treasury would be permitted to curtail the optional public works program embodied in the Emergency Relief & Construction Act was removed by President Hoover's announcement that the administration would do everything possible "in order to further aid employment."

The White House announcement followed assurance by Secretary Mills that the $200,000,000 allotted for public buildings, rivers and harbors and flood control now is available.

The $100,000,000 available for post offices and other public buildings will be allocated among projects selected from a previously authorized list of $154,000,000.

To speed up the emergency building schedule Secretary Mills has obtained a ruling from Comptroller General McCarl permitting employment of outside architects. Execution of both the regular and emergency construction programs, that together total about $750,000,000, is still hindered, however, by the provision of the economy law requiring that 10 per cent must be deducted from the limit of cost fixed on all previously authorized projects. Whether this limit of cost applies to public works generally is still open to question but there is no doubt about its application to public building projects.

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Tie Association Changes Name

At a recent special meeting the National Association of Railway Tie Producers adopted a new constitution and changed the name to the Railway Tie Association. A new development is the creation of a statistical bureau to maintain a record of the number of ties stocked in the yards of the producers and the railroads.

Plans for Congress of Highway Men and Builders Take Form

PLANS for the Highway and Building Congress, to be held in Detroit, Jan. 16-20, are beginning to take definite form. So far eleven asosciations are reported to have formally signified their intention of taking part in the Congress and at least one other, the American Society of Municipal Engineers, is expected to take part. The change of its annual meeting plan is noted elsewhere in these pages.

On the first three days of the Congress, the individual associations taking part will hold separate meetings at their organization headquarters throughout the city. On Thursday all the organizations will merge to hold a session devoted to highways, and on Friday they will join to hold a session devoted to building and general construction.

Two exhibits will be held. The American Road Builders' Association will hold its Annual Road Show at the Municipal Airport, and efforts are being made to add to this show features of interest to architects and others in the building field. The National Sand & Gravel Association, the National Ready Mix Concrete Association, and the National Crushed Stone Association, instead of holding separate exhibitions as in previous years, will combine forces and hold a joint exhibit at the Book-Cadillac Hotel.

The principal objective of the Congress will be to focus public attention upon the economic advantages of highway building activity. Efforts will be directed toward plans for coordinating the financial, contractural, engineering, material and equipment interests of which the highway building industry as a whole is composed.

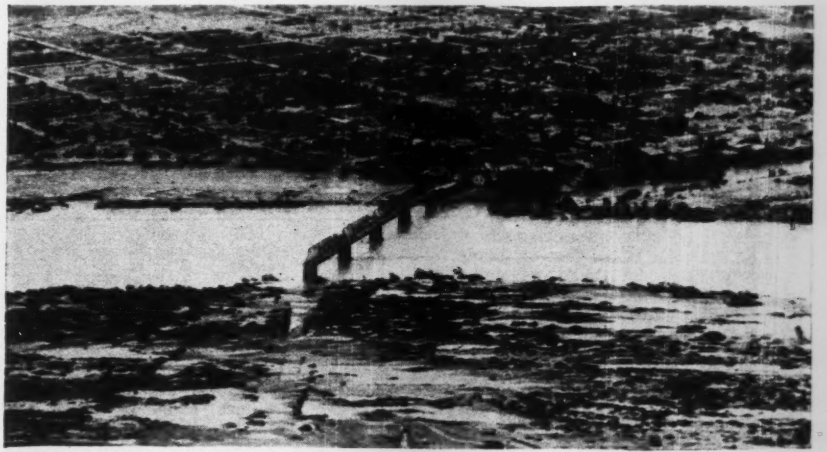
Company Would Surrender Contract for Hoover-Dam Power

Acting upon a resolution recently adopted by the city council of Los Angeles in which it was implied that the Southern California Edison Co. was attempting to "gobble up" the electric energy from Hoover Dam, the power company, on Sept. 5, formally offered "to assign to such agency as your honorable body (city council) may officially and legally designate all of its rights, titles and interests in and to the Hoover Dam power, subject only to the requirement that this offer be accepted within thirty days and that the proper steps are taken to hold the company harmless against any claims arising under said contract." The power company pointed out that it had no desire to take the power from Hoover Dam but that upon insistence of civic leaders of Los Angeles, representatives of the Metropolitan Water District and of the national government, "all of whom represented to the company that its participation in the contract for power was essential to the confirmation of the Boulder Canyon project, the company agreed to take and pay for 9 per cent of the power plus an additional 18 per cent if the latter amount should not be taken by the states of Arizona and Nevada."

◆

International Steel Institute

An international Institute of Steel Construction has been organized to facilitate the mutual clearance of information between the American Institute of Steel Construction and similar organizations in Europe. It is proposed that executive offices shall be established in The Hague, Holland. At present institutions similar to the American organization are in existence in Belgium, Germany, England, France, Holland, Hungary, Italy, Poland, Czechoslovakia and Switzerland.



Acme Photo

FLOODS DO EXTENSIVE DAMAGE IN RIO GRANDE VALLEY

A flood of unusual magnitude has been moving down the Rio Grande valley from Eagle Pass, Texas, south to the Gulf. The peak was expected to reach Brownsville about the 12th or 13th of the month.

Because of more adequate levees, floodways, and other protective measures on the American side, the damage has been less there than on the Mexican side of the river. The accompanying photograph shows the bridge between Del Rio, Texas, and Villa Acuna, Mexico, with one approach completely carried away. Spans of other bridges have been lost and some bridges on tributary streams entirely destroyed. There has been much flooding of low-lying land not protected by levees. No serious breaks have occurred in the levee system.

Municipal Engineers to Join Highway and Building Congress

The American Society of Municipal Engineers has cancelled the New Orleans convention, Nov. 14 to 18, and will hold its annual meeting at Detroit, Jan. 16 to 20, 1933, during the same week of the meeting of the Highway and Building Congress. There will be an independent three-days convention, without exhibits, and participation Thursday and Friday with the Highway and Building Congress. J. H. Neeson, president, C. W. S. Sammelman, secretary, and a third member, will become members of the general committee of the Highway and Building Congress.

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Regional Planning Conference to be Held in New York

A conference on regional planning, government and administration is to be held in New York City under the auspices of New York University, Oct. 18-19. Co-operating in the program are the National Municipal League, the National Conference on City Planning, the Regional Planning Federation of the Philadelphia Tri-State District, and the New York Regional Plan Association.

The following subjects are to be discussed: Problems of metropolitan government and administration under present economic conditions; coordination of public works and service in metropolitan regions; movement toward governmental integration in the metropolitan areas; foreign and American experience in the integration of government in metropolitan regions; specific problems of government, law and administration in executing metropolitan regional plans; and, displacement of states by political regions.

◆

Failure of Cable Kills Three Riding Bucket Down Water Shaft

Failure on Sept. 6 of a cable supporting a boom over a 175-ft. construction shaft to the Larabee St. entrance of the Chicago Ave. water tunnel precipitated to the bottom of the shaft the bucket in which nine workmen were descending. Three men were killed and the others injured.

Testifying before a coroner's jury, J. J. Versluis, engineer of water works construction, stated that the cable to the bucket did not fail but a cable controlling the raising and lowering of the boom parted. Somehow a section of the boom cable passing through the boom to an electrically driven drum of the hoist at the foot of the derrick became pinched, he said, and under the load of the men the cable parted bringing the boom down on the mouth of the pit. This produced a jerk on the bucket which parted the suspensory cable, thus releasing the bucket. The overhead gear crashed down on the men as the bucket struck bottom.

Ordinarily the men are transported down the tunnel by a passenger elevator guarded by regular safety appliances and with automatic push button control. The safety devices got out of order in a minor way which could have been repaired in 15 minutes, Mr. Versluis stated, but the men were impatient to descend and as the material bucket was tested for a capacity of 15 tons and its use not forbidden the men chose to descend in the bucket.

Third Subway in New York City Starts Operation

SEVEN YEARS after the first construction contract was let, the first section of the new Independent (8th Ave.) Subway System in New York was put into operation on Sept. 10. The subway has been built by the city through the agency of the Board of Transportation and is being operated by the Board of Transportation, the city having failed to obtain a satisfactory bid on the proposed operating contract earlier in the year. (*ENR*, March 31, 1932, p. 484).

The section of the subway now in operation is largely a four-track line extending through practically the entire length of Manhattan Island from Chambers St. to 211th St., a distance of 12.3 miles. In all it contains 46.6 miles of track. Its cost, exclusive of engineering and supervision, was $165,000,000.

Contracts for the remainder of the system, except for a short section through Sixth Ave., are all under way and many of them are well along toward completion. The total length of the Independent system will be 54.3 miles and the total trackage will amount to 179.1 miles. The total cost of work completed and under contract will amount to $648,000,000.

About Jan. 1, 1933, the Bronx Concourse line, the extension of the main trunk under Fulton St. and the East River into Brooklyn, the first portion of the Queens Boulevard line, and the Brooklyn crosstown line will be ready for operation. Other portions are expected to be ready for service by Jan. 1, 1935, and the Sixth Ave. line about Jan. 1, 1938.

Engineer Operators

The new subway is being operated by an organization headed by John R. Slattery, former deputy chief engineer, as general manager. In forming the operating organization Col. Slattery has drawn heavily upon the engineering force that helped build the subway.

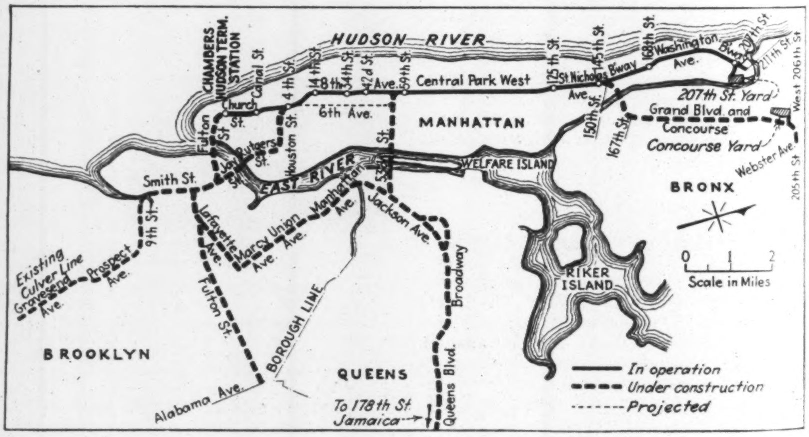
Col. Slattery is a graduate of West Point in the class of 1900 and served continuously in the Corps of Engineers from that time until his resignation in March, 1925, to become deputy chief engineer of the Board of Transportation under Robert Ridgway, the veteran chief engineer of the organization. At the time of his resignation, he was serving as district engineer for the War Department at New York City.

◆

New Highway Regulations Attacked and Defended

Private contract carriers in Texas have appealed to the United States Supreme Court in the hope of upsetting the decision of the federal district court of the Southern District of Texas, which upheld the act recently passed by the state legislature requiring private contract carriers by truck or bus operating over the highways of the state to obtain a permit from the state railroad commission and to comply with other regulations established by the commission. The district court stated, "Those engaged generally in the unregulated business of the carriage of goods for hire may not, merely because they carry usually for single individuals and upon special terms, by invoking the fourteenth amendment, maintain the right to continue to do such business on public roads, against the will of the state asserted by statute that they shall not do so." The contract carriers maintain that the legislature cannot by mere legislative declaration convert purely private business into one affected with a public interest in such a way as to be able to control and regulate it.

Limits on the size of trucks operating over the highways of Kentucky, set by an act passed by the state general assembly this year, do not violate the constitution, according to a decision by Judge H. C. Ford of the Franklin Circuit Court. Judge Ford based his decision on decisions of the United States Supreme Court as to the constitutionality of similar laws passed recently in other states. He stated that the Supreme Court clearly pointed out that such regulations prescribed by a state to prevent wear and hazard due to excessive size of vehicles and weights of loads are not repugnant to either the commerce clause or the contract clause of the federal constitution. Validity of other sections of the law delegating certain legislative functions to the state highway commission were questioned by Judge Ford but decision on these points, he said, need not be made until it is shown that their operation violates individual rights.



New York's new municipal subway system ultimately will serve the four boroughs of Manhattan, Brooklyn, Queens and the Bronx.

Construction Conference in Washington in October

The National Conference on Construction is to be held in Washington Oct. 13-14. Fifty or more interested organizations are expected to send representatives.

Economic construction will be the central topic for discussion. Elimination of waste, better information and planning, and improved organization as a means to economic construction will be reported on and recommendations on the subject will be made by the conference. Consideration also is to be given to the activities of the Home-Loan Banking system and of the Reconstruction Finance Corporation to determine what aid the industry can render to those institutions in the present emergency.

Among the organizations cooperating in the conference are: Associated General Contractors of America, American Institute of Architects, American Engineering Council, National Association of Builders' Exchanges, Investment Bankers Association, American Face Brick Association, American Bankers Association, National Lumber Manufacturers Association, Portland Cement Association, American Institute of Steel Construction, National Association of Credit Men, Common Brick Manufacturers Association, Mortgage Bankers Association, National Retail Lumber Dealers Association, National Association of Real Estate Boards, National Crushed Stone Association, National Plumbing and Heating Institute, United States Building and Loan Association, and the National Builders Supply Association.

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Permit for Hydro-Electric Plants on Tennessee Rivers Sought

Application for a permit to build four dams having an installed capacity of 124,500 hp. has been made to the Federal Power Commission by the Holston River Power Co., of Johnson City, Tenn. The company holds a preliminary permit covering the projects in question.

The projects provide for four dams on the South Fork of the Holston river, dam No. 1, located 4½ miles above Kingsport, Tenn., to be 86 ft. high; dam No. 2, 1⅓ miles below the confluence of the South Fork and the Watagua River, 140 ft. high; dam No. 3, 1¾ miles above Bluff City, 160 ft. high; and dam No. 4, 14½ miles above Bluff City, 182 ft. high. The latter dam would be an earthfill structure and the others would be of concrete, gravity type. Dams No. 2 and No. 4 would have considerable storage capacity. The combined usable storage will amount to 253,000 acre-ft. The prime power of the site amounts to 30,480 hp.

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Hoover Dam Notes

An extremely fine clay, carried in the recent flood waters of the Colorado River from the cloudburst area in southern Utah, has temporarily put out of commission the water filtration plant at Boulder City. The fine clay clogs the filters so rapidly that it is impossible to get a sufficient amount through to meet the water demands of the community. While attempting to cope with the situation the water storage tank was gradually depleted until it was necessary to start hauling the water in tank cars from Las Vegas. Water users have been urged to reduce demands to a minimum during the emergency which is expected to last until the flood waters have subsided. Water in the town is shut off entirely except during the morning and afternoon hours.

* * *

Accounts in the daily press of the flooding of the tunnels at Hoover dam on Aug. 31 and Sept. 1 were exaggerated. Reports reaching Elwood Mead, Commissioner of Reclamation, indicate that no important loss was sustained. Concreting operations were held up for two days and a portion of the third day. The discharge of the Colorado River at the time of the flood slightly exceeded 58,000 sec.-ft. The contractor, believing that the flood period had passed, had torn down the concrete cofferdams at the outlet portals of all diversion tunnels, as well as some of the earth embankments. Despite the flood, 368 ft. of side wall, 402 ft. of arch and 128 ft. of invert lining in the tunnels were poured during the week under review. The Black Canyon mixing plant produced 3,368 cu.yd. of concrete during the week.

* * *

The Bureau of Power and Light of Los Angeles has advised the Bureau of Reclamation that the turbines to be installed in the city's part of the power plant must be designed for both 50 and 60 cycle operation, as the city contemplates changing the frequency of its system to 60 cycles sometime in the future. This requirement necessitates the adopting of slower speed for the main turbines in order to permit satisfactory operation, and good efficiency when operating at the 60 cycle speed. This matter was taken up with the four major turbine manufacturers and it was decided to adopt a speed of 176.5 r.p.m. for 50 cycle operation and 212 r.p.m. for 60 cycle operations. This has been approved by the city of Los Angeles.

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Personal Notes

Frank H. Stephenson, formerly of the Detroit water department, has been appointed one of the engineering examiners of the advisory engineering board, Reconstruction Finance Corp., Washington, D. C.

Edward D. Ardery, lieutenant colonel, Corps of Engineers, has been assigned to duty as district engineer of the second New York and the Puerto Rico engineer districts. He is at present stationed in the Canal Zone in command of the 11th Engineers.

Robert L. E. Ward, formerly in charge of minor waterways, navigation locks and government dredges in the First New Orleans District of the U. S. Engineer Office, is now assistant to the district engineer.

Walter A. Bates, **B. Bates** and **Charles I. Bates** have incorporated under the name of Walter Bates Company for the practice of civil and mechanical engineering at Gary, Ind.

A. B. Hargis has been appointed head of the school of engineering of the University of Mississippi at University, Miss. For the past eleven years he has practiced as a consulting engineer and as city engineer of Jellico, Tenn.

Obituary

James L. Bernard, chief mechanical engineer, American Bridge Co., died at his home in Beaver, Pa., Aug. 20, after a short illness. Mr. Bernard was born in Philadelphia in 1870; graduated from the University of Pennsylvania in 1892. Upon graduation he went first to the A. & P. Roberts Co. and upon the formation of the American Bridge Co. in 1900 he became assistant mechanical engineer under James Christie. Four years later upon the retirement of Mr. Christie he was appointed mechanical engineer to the company, the position which he held until his death.

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SOCIETY CALENDAR

AMERICAN ASSOCIATION OF ENGINEERS, annual convention, Washington, D. C., Sept. 26-28.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual meeting, Washington, D. C., Nov. 14-18.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, annual meeting; date and place not fixed.

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, Washington, D. C., Oct. 24-27.

AMERICAN SOCIETY OF CIVIL ENGINEERS, fall meeting, Atlantic City, N. J., Oct. 5-8.

AMERICAN SOCIETY OF MUNICIPAL ENGINEERS, annual meeting, Detroit, Mich., Jan. 16-20.

AMERICAN WELDING SOCIETY, fall meeting, Oct. 3-7, Buffalo, N. Y.

ASPHALT INSTITUTE, Asphalt Paving Conference, New Orleans, La., Dec. 5-9.

INTERNATIONAL CITY MANAGERS ASSOCIATION and GOVERNMENTAL RESEARCH ASSOCIATION will hold a joint annual conference at Cincinnati, Ohio, on October 24 to 26.

NATIONAL ASSOCIATION OF RAILROAD AND UTILITIES COMMISSIONERS, annual meeting, Hot Springs, Ark., Nov. 15-18.

NATIONAL COUNCIL OF STATE BOARDS OF ENGINEERING EXAMINERS, annual meeting, New York City, Sept. 29-Oct. 1.

NATIONAL SAFETY COUNCIL, annual congress, Washington, D. C., Oct. 3-7.

NEW ENGLAND WATER WORKS ASSOCIATION, annual meeting, Springfield, Mass., September 27-30.

SOUTHWEST WATER WORKS ASSOCIATION will hold its 21st annual convention at Fort Worth, Texas, Oct. 10-13.

MISSOURI WATER AND SEWERAGE CONFERENCE will be held in Sedalia, Mo., Oct. 13-14.

WEST SHORE WATER PRODUCERS ASSOCIATION opened its fall meeting Sept. 9 at Milwaukee with talks on the new 60-m.g.d. turbo-centrifugal pump recently installed at the Riversied station and a 6,000,000-gal. welded steel storage reservoir under construction. H. H. Brown, engineer in charge of design and construction of pumping stations, stated that this unit was the second largest pump in point of horsepower in the country. (The 60-m.g.d. pumps at Howard Bend Station, St. Louis, have a lift of 360 ft.) On Aug. 9 in an official test (A.S.M.E. code) of 6 hours the unit developed a duty of 202,160,000 which, reduced to the specifications is 197,900,000 or 2½ per cent better than the guarantee. It pumped at the rate of 67.7 m.g.d. under 304 ft. head with a thermal efficiency of 21.3 per cent. This station now houses a total capacity of 160 m.g.d. whereas it was intended for vertical triple units of 104 m.g.d. only. The storage tank was described by J. W. Tanghe, assistant engineer, water department. It is located in the western part of the city in the high lift section which in recent years has been taxed to capacity during peak periods of sprinkling.

Bid Opening for Big Dam at Los Angeles Postponed

In order to give more time to prospective bidders on the $10,000,000 dam No. 1 of the Los Angeles Flood Control District, the opening of bids which was scheduled for Sept. 6 has been put off until Sept. 19.

On Aug. 8 the district rejected the one bid received for the construction of the dam and readvertised for bids. The new call for bids permits the bidders to submit separate proposals for excavation, tunnels, rockfill, concrete, grouting, and placing of steel.

The dam is to be a rockfill structure 208 ft. high with a face of concrete on the upstream side. C. Eaton is chief engineer of the flood control district.

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Engineering Contracts and Capital

BOLSTERED UP by highway awards aggregating 16 million dollars, the past week's total of heavy engineering construction contracts reached $34,698,000, a high figure that has been surpassed by only two weekly reports this year. The week's total is more than the contracts reported for the previous two weeks. Highway lettings are the largest reported for any single week of the year. Federal government awards totaled 10½ millions, the highest in seven weeks. Private contracts held to their usual low figure, amounting to $2,633,000. Large road lettings were reported from the following states: Minnesota, $1,783,000; New Jersey, $911,000; North Carolina, $707,000; Iowa, $1,418,000; Michigan, $1,131,000 and Illinois, $1,005,000. The largest single contract let during the week was for the Philadelphia postoffice, $4,400,000. Mississippi River levee contracts in Louisiana aggregated $1,796,000.

New capital issues for the week amounted to only $6,200,000, half of which were waterworks bonds for the city of Los Angeles. No private issues were reported.

Pittsburgh Strike Continues—The strike of hoist operators that has tied up work on the new Pittsburgh postoffice for more than eight weeks, is still in effect with no signs of settlement.

Short Strike in St. Louis—A walkout on the new municipal auditorium under construction in St. Louis, caused by the presence of non-union teamsters on a grading subcontract, lasted but two days. Several trades, involving more than 100 men, were affected by the strike.

Painters Return in New York—Nearly 5,000 members of the Brotherhood of Painters, who have been on strike in New York City since July 14, returned to work at a scale of $11.20, pending further conferences. A former agreement, which has expired, called for a scale of $13.20. Employers offered $10 on new work and $8 on old work, which was refused by the workmen, who demanded $11.20, a reduction of 15 per cent in line with recent reductions in other trades in the city.

Minnesota Highways Provide Work—More than 1,500 workmen have been provided jobs in Minnesota with the start of the state's 4 million dollar road program.

Highway Engineers Take Cut—Engineers and other employees of the state highway departments of Indiana and Utah are to receive salary reductions, according to announcement from the highway departments of those states.

Lumber Situation Improves—Orders received at lumber mills continued their steady climb of the last four weeks, exceeding production by 67 per cent during the week ended Sept. 3, according to the National Lumber Manufacturers Ass'n. Softwood orders were 10 per cent above those reported for the preceding week, 34 per cent above the weekly average of the year and only 9 per cent below the corresponding week last year. Hardwood orders were 14 per cent below last year.

Pipe price correction

The prices of cast-iron pipe appearing on page 274 of the September 1 issue of *ENR* are incorrect due to a typographical error in correcting the entire list. Following are correct market prices of 4-in and 6-in. pipe, per net ton, for class B and heavier pipe, f.o.b. in carload lots, as furnished by the United States Pipe & Foundry Co. Gas pipe and class A, $3.00 per ton extra.

	4-in.	6-in. and over
Atlanta	$37.50	$34.50
Boston	39.00	36.00
Chicago	41.50	38.50
Dallas	45.50	42.50
Los Angeles	41.50	38.50
New York	36.50	33.50
Philadelphia	35.00	32.00
Pittsburgh	39.50	36.50
St. Louis	40.50	37.50
San Francisco	41.50	38.50
Birmingham	33.00	30.00
Burlington, N. J.	33.00	30.00

Contracts and Capital

CONSTRUCTION

(Thousands of Dollars)

	Weekly Average Sept. 1931	Weekly Average Sept. 1932	Week Sept. 15, 1932
Federal government	$10,409	$5,712	$10,507
State and municipal	21,880	14,316	21,558
Total public	$32,289	$20,028	$32,065
Total private	11,950	2,310	2,633
Week's total	$44,239	$22,338	$34,698
Cumulative, Jan. 1 to date:			
1931 construction			$1,894,331
1932			867,222
Decrease, 52 per cent.			

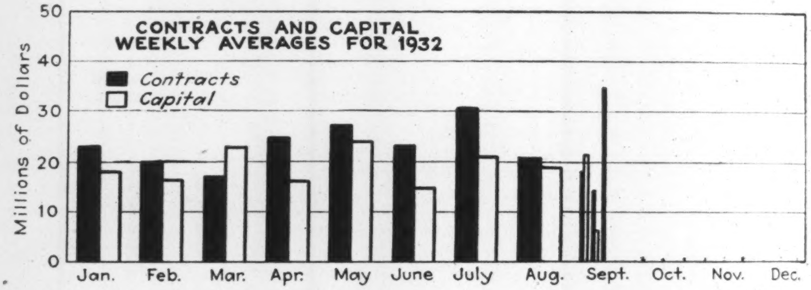
NEW PRODUCTIVE CAPITAL

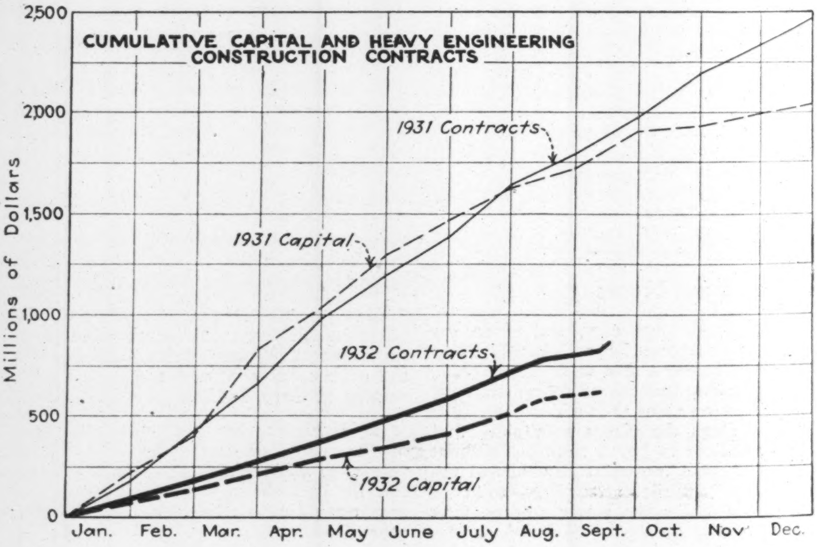
(Thousands of Dollars)

	Weekly Average Sept. 1931	Weekly Average Sept. 1932	Week Sept. 10 1932
Total private and public	$45,500	$14,000	$6,200
Cumulative, Jan. 1 to date:			
1931 new capital			$1,806,000
1932 new capital			622,000
Decrease 65 per cent.			

ENR Cost and Volume Index

Cost		Volume	
September, 1932	157.96	**August, 1932**	111
August, 1932	156.80	July, 1932	166
September, 1931	171.40	August, 1932	187
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.85	1930 (Average)	260
1913 Average	100.00		



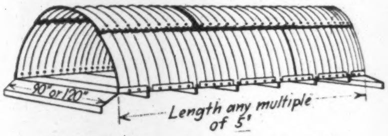


Construction Equipment and Materials

Armco Culvert of Half-Circle Form Made of Corrugated Plate

To provide a strong drainage structure that will give adequate water-way area without the headroom necessary for full-round pipe, the Armco Culvert Manufacturers Association, Middletown, Ohio, has developed part circle, multi-plate pipe. The accompanying illustration shows the design of this type of construction with five- or three-gage flat base plate, each 30 in. wide, and with an apron plate at each end of the pipe.

The ends of each base plate are turned up 4½ in. so that the arch plate, can be bolted to them. Stiffness is provided by turning the sides of the base plates down to form a 4½-in. lip. The pipe is manufactured with 3, 4, and 5 arch plates to form spans ranging from 90 to 220 in. and in length in multiples of 5 ft. The waterway area provided thereby is equivalent to full round pipe of from 60 to 84 in. in diameter. The arch plates are available in 3, 5 or 7 gage thickness.



New half-circle culvert requires small amount of headroom.

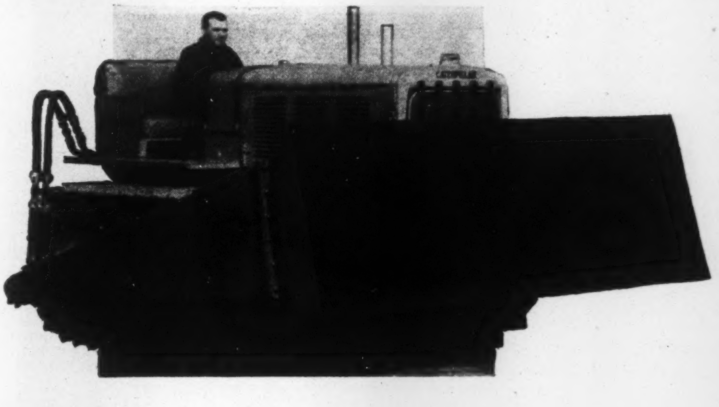
The manufacturer states that before announcing the new product, a strength test was conducted on a 120 in. base culvert. The arch was made of 5-gage metal and the base of 3-gage. The foundation was 9 in. of dry sand. Under a load of 76,025 lb., contacting the arch at three points, the crown deflected a maximum of 1¼ in.

◆

Hydraulically Operated Bulldozer For Tractor Mounting

A hydraulic bulldozer for attachment to all sizes of tractors is announced by Blaw-Knox Company, Pittsburgh. Pa. The power for control is enclosed in the side arms, protected from dust and dirt. The bulldozer bowl is curved, designed to lift and roll the material being moved. It is electrically welded and heavily reinforced, and supported by two side arms attached to the tractor truck-frame. The tractor operater controls the bulldozer through the action of a double-acting Ateco hydraulic pump which, with a single control, holds the bowl with the cutting edge at any desired elevation. A movement of the lever in one direction raises the bowl, moving it in the opposite direction lowers it. There is a bypass safety valve in the piston which allows the bowl to lift if it encounters large boulders or other removable construction.

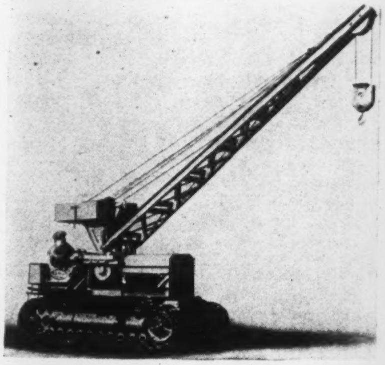
Hydraulic bulldozer by Blaw-Knox.



◆

Hydraulic Crane on Tractor

A full revolving hydraulic crane mounted on a Cletrac 35 is announced by the Cleveland Tractor Company, Cleveland, Ohio. The welded frame is mounted on the tractor by fastening the front end of the ⅜-in.-thick radiator shield to the motor frame, carrying a portion of the load on the equipment mounting spring. The outside support comes on the equipment mounting trunnion on large coil springs. The turntable is revolved by a six-cylinder, hydraulic radial motor located at the left-hand corner of the turntable cover. Another identical motor is mounted on the right-hand corner of the turntable, operating the drum for raising and lowering the table. Pressure is supplied for operating the motors by a six-cylinder pump mounted at the rear of the transmission case and driven by the power take-off of the tractor. The overall width of the unit is 87 in. The boom will reach 20 ft. in any direction.

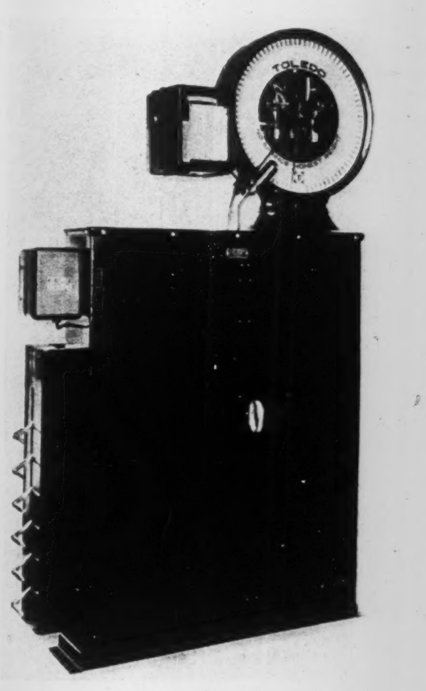

Cleveland Tractor Co.'s full-revolving hydraulic crane.

◆

Material Batching Made Automatic By New Toledo Scale

Weight batching of materials is reduced to a cycle of lever and button operations by the new automatic batching equipment recently developed by Toledo Precision Devices, Inc. The new assembly consists of a Toledo Scale equipped with a photo-electric tube, a lever system and a set of beams and is designed to make batching operations automatic.

A tank or hopper for the batching is mounted on a special assembly on the scale platform. There is a set of beams for each ingredient, regulated by a system of hand levers on one side of the scale. Buttons control the starting of the flow of materials. When the desired weight has been placed on the scale, the photoelectric relay stops the flow. Attached to the head of the scale is a graphic recorder.



Material flowing into batch hopper is stopped by photoelectric cell when proper weight is reached.

◆

High-Efficiency Centrifugal Pump

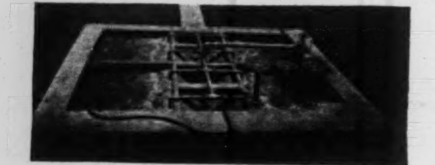
A new line of pumps for which high efficiency and long life are claimed has been announced by the Fairbanks-Morse Manufacturing Co., Beloit, Wis. The range of pump sizes is from 3 to 6 in., and capacities vary from 390 to 1,500 gal. per minute at 165-ft. head. The manufacturer states that a high hydraulic efficiency is obtained by the use of asymmetrical volute suction. The water passages not only change in cross-section but their direction changes in relation to the horizontal and vertical axis of the pump. This streamlining of the flow results in improved efficiency and avoidance of cavitation.

The pump is built with a spilt casing and is mounted on a welded steel base. The new pump series is designed as Fig. 5803.

◆

New Aerator-Mixer for Water Plants

A new aerator-mixer, of the elevated diffuser type, using air for agitation, is announced by the Link-Belt Co., Chicago, Ill. The diffuser equipment is located at one side of a rectangular tank, which has a maximum width of 16 ft., a maximum depth of 12 ft. and a detention period of about 15 min. The compressed-air requirements are about 50 cu.ft. of free air per minute per million gallons of water. The power consumption is 500 kw. The intensity of agitation is regulated by valves controlling the flow of air to the different diffuser tubes.



Link-Belt's new aerator-mixer.

◆

New Equipment in Brief

Diesel Engines. A diesel engine for automotive and industrial use is announced by the Cummins Oil Engine Co., Columbus, Ind. The manufacturer states that the engine weight is comparable to that of a gasoline engine of similar displacement. The new engine is made in both 6- and 4-cylinder models of 4⅞ in. bore and 6 in. stroke. Starting is by means of an electric motor. The governor of the engine can be adjusted to give working speeds up to 1,800 r.p.m.

Track Wagons. A complete line of track wagons, including bottom-dump, end-dump, log, pipe and industrial track wagons, has been added by the Allis-Chalmers Tractor Division, Milwaukee, for distribution through the company's track-type tractor dealers. Four models of bottom-dump wagons are being built in 5½, 6, 7 and 8-cu.yd. capacity. An 8-cu.yd. gravity rear-end dump wagon is included. A 15-ton log, pipe or industrial track wagon is available with or without front carrier.

Street Signs. Municipal Street Sign Co., Inc., 299 Broadway, New York, N. Y., announces a new low-price wing street sign. Each sign unit consists of two double-faced 16-gage porcelain enamel signs held in a malleable iron frame. The overall size of the frame is 7x23 in. A steel post is provided, 3½ in. in diameter and 12 ft. long.

Sieve Shaker. The Newark Wire Cloth Co., Newark, N. J., has recently announced its "End-Shak" testing sieve shaker. The machine is designed to shorten the time required for adequate shaking of testing sieves. The machine weighs 275 lb. and includes a motor and automatic time switch. A standard ¼-hp. motor is used. The machine is designed for 8-in. sieves and can be adjusted to hold as many as thirteen of them.

Six-Wheel-Drive Truck. Manufacture of a 15-ton six-wheel-drive auto truck has been commenced by the Four Wheel Drive Auto Co., Clintonville, Wis. The vehicle, with power on all six wheels, is powered by a 125-hp. engine through a four-speed transmission with a dual range sub-transmission which gives the truck eight speeds ahead and two in reverse. The truck is equipped with a cab and a steel body which measures 18 ft. long and 8 ft. wide. The overall length of the truck is 27 ft. 2 in. and it weighs 20,945 pounds. The truck was ordered by the Iraq Petroleum Co. for use in building a 1,300-mile pipe line across the Syrian desert.

Electric Hand Saw. A new light weight portable electric hand saw is announced by the Porter-Cable-Hutchinson Corp., Syracuse, N. Y. The two new models weigh 18 lb. and 23 lb., respectively, and are readily portable. The saws are powered by 1-hp. and 1½-hp. motors, controlled by trigger switch from a pistol drip.

Draglines. A new 2-cu.yd., high-speed, high-power dragline has been announced by the Harnischfeger Corp., Milwaukee, Wis. The new machine, known as model 780, has a hoist line speed of 180 ft. per minute, dragline speed of 150 ft. per minute, and a rotating speed of 3 r.p.m. The manufacturer states that the new machine has a high degree of mobility. The track mechanism is gear driven and is fully inclosed. In high gear the machine has a speed of 0.89 miles per hour.

Electric Lamp. The General Electric Co. announces a high-powered electric lamp of radically new design. The new lamp omits the conventional base which is secured to the bulb by cement or clamping. Instead, the new base consists of a glass cup with two metal posts sealed to it. Connection to the socket is made through the lower part of the post, which consists of a cylindrical prong with a shoulder for accurate seating. Instead of the filament and leading-in wires being supported by a glass stem structure, in the new lamp the supporting structure is made from one piece of channel nickel. The new lamps are considerably lighter in weight and shorter than the conventional type.

Crane Scale. A crane scale that automatically weighs loads while in transit has been introduced by the Kron Co., Bridgeport, Conn. The scale, which is placed in the lifting line and becomes a part of the line itself, indicates the weight of the load on a large dial. The design of the dial mechanism provides one point adjustment to simplify the adjustment. A tare beam adjustment inside the frame permits the weigh-man to balance off sling chains, cables, cradles or containers to give a net reading on the dial.

Explosives. A new type of explosive, to be known as Hi-Velocity Gelatin dynamite, has recently been developed at the Eastern laboratory of E. I. du Pont de Nemours & Co., Wilmington, Del. This is described as a straight gelatin that detonates at high velocity with a No. 6 cap, even when shot unconfined, and tests are said to have proved that the material invariably reaches its high velocity within the first 8-in. cartridge. The new gelatins will be offered in the 60 per cent, 70 per cent and 80 per cent straight gelatin grades, and in diameters not less than 2[illegible]

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New Publications

Dust Collector—Catalog No. 1391, issued by the Blaw-Knox Company, Pittsburgh, Pa., describes the framed-back dust collectors made by that company. The collectors are adaptable for use in handling dry industrial dust or fumes, such as are encountered in plants handling, grinding, grading and processing material.

Ball Bearings—"Lubrication of New Departure Ball-Bearings" is the title of a twelve-page pamphlet recently published by the New Departure Manufacturing Company, Bristol, Conn. The pamphlet consists of a comprehensive technical study of the lubrication requirements of ball-bearings.

Welding Fittings—Bulletin No. WT-17 has just been issued by the Bonney Forge & Tool Works, Allentown, Pa., containing a description of the engineering principles of welding fittings. Working data, tables of sizes, and illustrations of typical installations are included. Attention is confined to Bonney Weldolets and Thredolets.

Car Pullers—The Fridy line of car pullers and hoists is described in Bulletin No. 115, published by the Fridy Hoist & Machinery Co., Mountville, Pa. It is a booklet of 16 pages describing the motor and gas-engine-driven car pullers of the friction and capstan types.

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Business Notes

HENDRICK MANUFACTURING CO., Carbondale, Pa., announces that R. F. Baldwin has been appointed Philadelphia district sales representative. Mr. Baldwin will handle the sale of Mitco interlocked steel grating, Shur-Site treads, Armorgrids and Hendrick Perforated Metal Grilles in southeastern Pennsylvania, southern New Jersey and the states of Delaware and Virginia.

FEDERAL MOTOR TRUCK CO., Detroit, Mich., announces the appointment of Earl W. Winans as chief engineer, following the resignation of George B. Ingersoll. Mr. Winans has been associated with the company for 16 years. For many years he served as special equipment engineer and also headed the federal body division, in charge of engineering and design.

ATLAS POWDER CO., Wilmington, Del., announces that E. Frost has been appointed director of sales to succeed the late J. W. Mathews. Mr. Frost will have full charge of all selling activities in the explosives department.

AUSTIN-WESTERN ROAD MACHINERY CO., domestic sales organization of the Austin Manufacturing. Co., and the Western Wheeled Scraper Co., announces that it will handle the industrial sales and service of Cletrac crawler tractors in 24 states, broadly the territory covered by the Mid-western, Southern and Southeastern states. The present Cletrac organization continues to handle nation-wide agricultural sales and industrial sales and service in all other territories.

WESTINGHOUSE ELECTRIC AND MANUFACTURING CO., East Pittsburgh, Pa., announces the appointment of E. C. Brandt as manager of renewal parts in all Westinghouse plants.

HERCULES POWDER CO., Wilmington, Del., has announced that all experimental and research work will be centralized at the new experiment station, near Wilmington. The Kenvil, N. J., branch of the experiment station will cease to function as a separate organization, and the Kenvil facilities will be taken over by the company's explosives department and placed under the jurisdiction of the adjacent Kenvil plant. The executive offices of the station will hereafter be at the Hercules home office, Delaware Trust Building, Wilmington, Del. The new Hercules experiment station, which was completed and put in operation last year, is located on a 300-acre tract of land about 5 miles west of Wilmington.